Vol 16

THE MONTHLY

JOURNAL OF SCIENCE,

AND ANNALS OF

BIOLOGY, ASTRONOMY, GEOLOGY, INDUSTRIAL ARTS,

MANUFACTURES, AND TECHNOLOGY.

Vol. I. (THIRD SERIES)
No. LXXII.

DECEMBER,
1879.

CONTENTS.

ARTICLES.	PAGE
1. A Visit to the Ancient Observatory at Delhi, locally known as the "Junter Munter." By H. A. TRACEY, Major R.A...	777
2. The Action of Light on Plants	784
3. Technical Education in England, France, and Germany	790
4. Accidents resulting from the Heat of the Comstock Mines	706
5. Are the Chemical Elements Simple Bodies?	800
6. Darwinism and Articulate Speech	804
7. A Remarkable Water and Gas Geyser	805
ARTICLES—*continued*	PAGE
8. The Transit of Venus in 1874	806
NOTICES OF BOOKS.	
A Handbook of Double Stars, with a Catalogue of twelve hundred Double Stars and extensive Lists of Measures ..	810
PROCEEDINGS OF SOCIETIES.	
Astronomical Society	811
Chemical Society	812
Geological Society	812
Institution of Civil Engineers ..	813
Physical Society	814
Royal Society	816
Royal Geographical Society ..	819
Academy of Sciences (Paris) ..	821
NOTES.– Biology, Microscopy.	

LONDON:

3, HORSE-SHOE COURT, LUDGATE HILL.

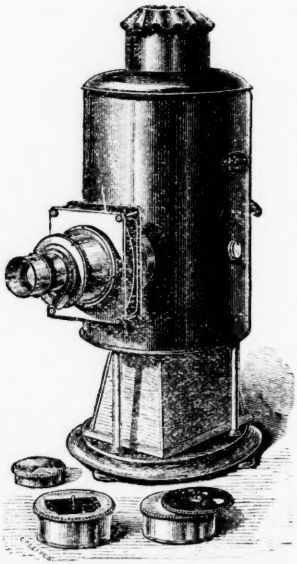
Where Communications for the Editor and Books for Review may be addressed.

PRICE ONE SHILLING AND SIXPENCE.

XUM

BROWNING'S ELECTRIC LANTERNS.

SCREEN SPECTRUM APPARATUS.



JOHN BROWNING begs to inform Spectroscopists that he has just introduced a new metal body ELECTRIC LANTERN, with an Electric Regulator specially adapted to the same, for showing Diagrams, and exhibiting Spectra on a Screen; thoroughly efficient in action, and yet economical in price.

The Automatic Regulator is of the best construction, exactly similar to his now well known large Regulator, but arranged to burn with a smaller number of cells.

Price of the Electric Lantern for medium size Lamp, with metal body, japanned bronze green, with two nozzles, interchangeable—one for showing diagrams, with 3½-inch condensers, the other for spectrum analysis £7 10 0

MEDIUM SIZE AUTOMATIC ELECTRIC LAMP.

This Lamp works well with from 20 to 30 pint Grove's Cells, or the same number of quart Bunsen's £7 10 0

Illustrated Catalogue of Spectroscopes, Price 6d.

HOW TO WORK WITH THE SPECTROSCOPE. By JOHN BROWNING. **Price 1s. 6d.**

Illustrated Catalogue of Electric Lanterns, Magic Lanterns, Slides, &c., price 6d.

LISTS OF PRICES SENT FREE.

JOHN BROWNING,

Optical and Physical Instrument Maker to H.M. Government, the Royal Society, the Royal Observatory of Greenwich, and the Observatories of Kew, Cambridge, Melbourne, the U.S. Naval Observatory, Cambridge and Harvard Universities, Hoboken College, &c., &c.

63, STRAND, LONDON, W.C.

FACTORY—SOUTHAMPTON ST., LONDON, W.C.

[Advertisements continued at end of Journal.

S.

s just
ic Re-
ibiting
price.
to his
umber

10 0

P.

10 0

OHN

ice 6d.

ociety,
y,

rnal.

XUM

THE MONTHLY

JOURNAL OF SCIENCE.

DECEMBER, 1879.

I. A VISIT TO THE ANCIENT OBSERVATORY AT DELHI, LOCALLY KNOWN AS THE "JUNTER MUNTER."

By H. A. Tracey, Major R.A.

DURING the visit of H.R.H. the Prince of Wales to Delhi, in the winter of 1875-76, my battery, among many others, was temporarily stationed there, and after H.R.H.'s departure I employed our few leisure days in visiting the interesting remains of ancient grandeur that dot the country for 10 or 12 miles to the south of the modern city.

One of the most conspicuous is the great Sun-dial, erected by Rajah Jey Sing, about A.D. 1720. Its gnomon is a very remarkable object, rising stiff and angular some 60 feet above the plain. Those who mount the narrow stairs that lead to its summit find it crowned by a "Lingam," sure sign of a worship of "Baal" as descended to these days. There were the yellow flowers and grains of rice on and about it, showing that it is a "high place," still used by the neighbouring peasantry.

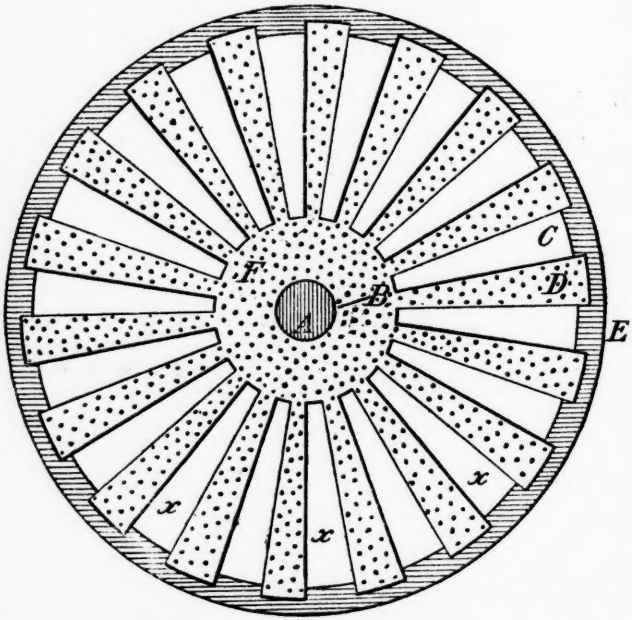
This Sun-dial, though the most prominent, is not the most important part of the remains of the Observatory. Two low towers, about 24 feet high and 60 feet in diameter, attract one's attention when on the gnomon, and lie due south of it. As seen from that more elevated spot their cylindrical exterior is at once noticed, and the observer has also the opportunity of remarking that the tower is open to the heavens; that a central pillar rises in each to the same height as the walls, which have deep vertical recesses on

XUM

their inner surface, so that, while the exterior plan of each tower would be represented by a circle, a cogged wheel would show the shape of the floor inside.

From a certain spot on the flight of steps running up the gnomon, the central pillar of each tower can be observed as being truly level with its surrounding wall. From this spot another peculiarity can be seen:—The projecting teeth of

FIG. 1.—GROUND PLAN OF TOWERS. $\frac{1}{100}$ Scale (Natural).
Shaded portions brickwork; dotted parts rank grass and filth.



A. Centre of pillar. A B. Radius of pillar, 32·5 inches. A C. Radius of interior of tower, 325 inches. A D. Radius of cogs, 350 inches. A E. Radius of exterior of tower, about 360 inches. A F. Unoccupied interval, about 130 inches. *x x*, &c. Raised sectors with "ivory" cement covering.

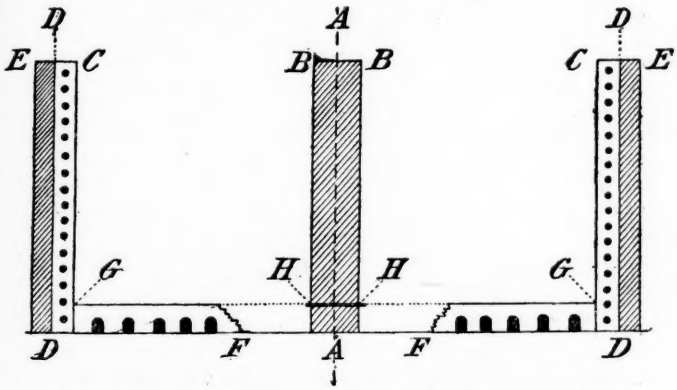
the imagined cog-wheel are apparently the same as the intervals between them. Both the towers seem in every respect alike, except that the nearest of the two towers has its northern cog in a line with us and its central pillar, while the furthest tower has one of the intervals between

the cogs in the same line, as if indeed the southern tower had been turned in azimuth through the space of one cog. With this exception the towers seemed similar.

The towers are well built of brick, and plastered. A small doorway in each led to the inner floor, 5 or 6 feet below the present level of the adjacent ground.

In the interior the first rough plaster is covered with a fine hard one everywhere; and that again on the portions marked with lines, &c., for observation, bore a still finer plaster, that, wherever I remarked it, had a surface, touch, and colour that can fairly be compared to ivory.

FIG. 2.—VERTICAL SECTION THROUGH CENTRE. $\frac{1}{200}$ Scale (Natural).



A A. Centre of pillar. A B. Radius of pillar, 32·5 inches. A C. Radius of interior of tower, 325 inches. A D. Radius of cogs, 350 inches. A E. Radius of exterior of tower, about 360 inches. A F. About 130 inches. C G. 292·5 inches. C B G H is a square, and the angle C G B = 45°. The dots along C G are the pigeon-holes for the feet.

A zealous "Sub" helped me in making the measures from which the accompanying plan and section of the towers are drawn.

To commence with the plan, Fig. 1.

The floor may roughly be described as a cart-wheel in shape, the eighteen spokes of which are raised from the ground (see Fig. 2) on five—I think, but not recorded in my notes—low arches. The intervals between the spokes are of equal breadth with the raised parts, and are at present covered with the exuviæ of the human and animal population of the neighbourhood. These portions of the floor each extend about 2 feet radially into the thickness of the

wall, and, carried up vertically, give the cog-wheel-like appearance to the inner plan of the towers, as noticed when looking down on them from the gnomon. On each side of these recesses are pigeon-holes, of a convenient size for the feet, so that, by straddling across from side to side, an observer can easily mount, resting his back against the wall, up to the top, and bring his eye with ease to the edge on either side, on which are marked the angles of depression from the edge of the flat top of the centre pillar. Along these vertical edges the degrees are numbered in Hindoo (Sanscrit), not Arabic figures, the *Z*ero being at the top, and the 45th degree at the angle where the vertical and horizontal portions of fine work meet (see the angle marked G in Fig. 2). The *Z*ero point (C, Fig. 2) was in every case removed. (Every fifth degree was marked in figures, the others by a line only.) I walked round the summit of each tower to assure myself of this, as I was anxious to find one *in situ*. It had apparently been marked by the edge of a stone about a foot square, and so would be a convenient size for grinding curry-stuff on. Such stones are in daily use by all the inhabitants of the country, and being ready cut and levelled would naturally be soon appropriated. And the flight of pigeon-holes led directly up to them.

Each of the observing recesses had three windows, lancet-shaped, together forming three rows of windows round each tower: they were of no apparent value, and were draughty and dangerous for an observer. Some were bricked up, and I regret I did not record the position of these, as it might have given an idea of the direction from which observations were most frequently taken.

The eighteen spokes being of the same width as the intervals between them, it follows that the circular floor was divided into thirty-six equal divisions of 10 degrees each. And now we learn the value of the *two* towers—as the raised "spokes," or "sectors" as we shall prefer to call them, in one occupied the place of the unmarked floor in the other. Each of these raised sectors, and the vertical wall adjoining them, had been once covered with the fine "ivory" cement I have spoken of. But little of it remains on the broad surfaces, as it seemed to have suffered from the weather and the frosts not uncommon here in January and February; though in the salient angles formed by the recesses I have mentioned it was more perfect than elsewhere, and the lines and figures on it were generally legible. They had apparently been drawn by some blunt fine-pointed instrument before the cement was quite dry. Each sector

was divided radially into six divisions by five deep lines, and each division into five subdivisions by finer lines. So each large division represented 10° divided by 6, or—

$$\left(\frac{10^\circ \times 60'}{6}\right),$$

100 minutes of azimuth angle; and consequently each finely-marked subdivision equalled 20′ of angle.

I am not able to say positively that these finer subdivisions were continued on the vertical walls. I saw some parts where the fine cement appeared intact, but not within reach, where I *thought* the finer lines apppeared, but I was not certain. They did *not* exist on the index edges, where the written numbers of the degrees were marked. The inner ends of the sectors were much damaged, the open space between them and the centre pillar being anything from 6 to 8 feet.

The centre pillar has a ring of well-cut stones, eighteen in number, on a level with and corresponding to the eighteen sectors. They are of the fine red freestone of the district, and project from the pillar about 2 inches (not exactly recorded in my notes). Their upper surface is level and finely dressed, and divided equally by radial lines into six parts. The space between each stone—equal in width to the stone itself—is occupied by a red stripe running vertically the whole length of the pillar. The pillar itself is divided above the level of the projecting stones, by clearly-marked red rings, into five horizontal blocks, each block being subdivided by finer horizontal lines into nine smaller blocks.

Judging by eye, and with the assistance of my Lieutenant on the opposite side of the tower, it was clear that the middle of each of the bolder red rings was intended to be (and indeed was) on the same level as the 36°, 27°, &c., marked on the index edges of the observing recesses. And the marks were as closely accurate as we were capable of discerning with the unaided eye. The level stone on the summit of each central pillar was in its place, with the edge angle very fine dressed.

In the northern tower, which is the one nearest the Sun-dial, the prolongation of the gnomon's western face is marked by a window, unlike the others in the tower. It is of lancet-shape, but extends from second to third row of windows counting from the ground; its *apex* marks the prolongation of the north and south line, while the same line on the opposite side of the tower falls exactly on the

edge of another window, signalised by being splayed out on that particular side into an exceptional shape, and leaving the edge required for observation dressed with the fine "ivory" cement. The N. and S. line only just clears the centre pillar. The same line is carried through the southern tower, falling on the other side of its centre pillar (I think so at least, though I did not record it in my notes made on the spot), and its position is again marked by fine edges of the "ivory" cement, though the windows are not of such exceptional shape as in the northern tower.

All the above lineal measures were made with a folding rule of box-wood, by Adie, of Edinburgh, and specially tested at the Observatory of that city for accuracy. It is 25 inches in length. One side of the rule was marked to tenths, and the other to half-tenths of an inch.

The measures on the walls and sectors we considered trustworthy; those connecting the walls with the centre pillar were carried out with difficulty. A plumb-line was dropped from some well-marked position at the edge of a sector, and then, by means of two boards alternately moved, the measure was carried step by step across the filth that covered the ground. A tight string gave a straight line, but no special means were taken for levelling. Direct measures from wall to pillar were also made in the same manner.

The general result of our measures were—

	British inches.
Radius of the interior of the tower	325·0
,, ,, centre pillar	32·5
Height of finely-cemented portion of tower, inside above the sectors: mean of several measures	293·8

In this last measure, which theory demands should be 292·5 inches, it must be remembered the original index edge had been removed for the vertical, and we were guided by eye alone, taking the centre pillar's top and the opposite side of the tower as our guide.

I noticed that the index markings for vertical angle were not too truly marked; several had double lines. Those in azimuth were not too accurate. The box-wood rule allowed of its being bent against the inner circumference of the wall, and the width of the divisions in azimuth were carefully recorded.

	Inches.
8 are each recorded as	5·75
1 is recorded as	5·70
1 ,, ,, ...	5·72
Mean	5·74

Each of these divisions represent 100 minutes of horizontal angle.

Having completed, as well as time permitted, our measures of the towers, we devoted our spare time on the second day to a closer inspection of the great Sun-dial.

It is built on the edge of a natural, or perhaps artificial, depression in the ground, so that, though it only stands some 60 feet above the general level of the country, its perpendicular face really has a front of about 90 feet, the excavation at its foot giving it that additional height. From each side of its foot, and (in plan) at rather less than a right angle, sweep up the great arcs on which the shadow falls.

The Western one is quite ruined: a large badger appeared its only tenant, and watched us. The Eastern one had enough remaining to enable us to follow the shadow over the few existing legible markings, by mounting a very narrow and hazardous flight of steps which followed the sweep of the arc. As I mounted the ruined steps, spare remnants of the "ivory" cement called my attention, and it was clear that the crest of the parapet between me and the gnomon was the dial on which the time was marked.

Waiting till the sun was low I was able to watch the shadow moving over some of the more perfect portions of the scale. The workmanship was kindred to that of the towers—brickwork, rough plaster, finer plaster, and for the inscribed portions the "ivory" cement. I was not able to measure the angular divisions of the circle on this arc, but I could see the markings were finer than could be read, or, in other words, the penumbra on the edge of the shadow was wider than the space between each of the finer marks, so that its fall on each could not be noted accurately by my unpractised eye. These smallest divisions were arranged in groups of five. A blank concentric space of the same angular value marked each block of five, and an inner curve again gave larger divisions, but there was no portion of plaster left large enough to count how the enumeration was commenced.

An eye accustomed to watch the record of this great dial could no doubt read it to a fraction of a minute; but with such a broad penumbra no two observers could, I think, give similar independent readings.

On our two visits to the top of the gnomon we took frequent measures of its angle; they all lay between—

$$28^\circ\ 15'\text{ and }28^\circ\ 45'\text{ (mean }28^\circ\ 30'),$$

or close on the real latitude of the spot.

The substructures and architectural arrangements for the Eastern arc of the Dial were made subservient to many purposes, chief of which we noticed a narrow gallery or chasm running due N. and S. I hardly know how to describe it. In ground plan it would be a narrow parallelogram, about 6 feet wide; in side elevation, wedge-shaped—its central line in the direction of the mean angular midday elevation of the sun; the vertical height of this wedge being that of the arc, or about 60 feet. The apex of this wedge is a well-cut horizontal slit, about 2 inches wide, in a finely-dressed stone, and not to be noticed at first in the ruined condition of the outside; but inside the curious vault at midday its meaning is evident, as the line of sunlight falls across an arc, ready marked, recording the sun's vertical height at noon during the year.

The visit was an interesting one, but I left the "Junter Munter" with the idea that it was only the scientific toy of a rich man, with yearnings maybe ahead of his time; and when "Jey Sing" was gathered to his fathers, I imagine the "Junter Munter" soon fell into a respectable disuse.

II. THE ACTION OF LIGHT ON PLANTS.

IN his Presidential Address at the Sheffield Meeting of the British Association, Dr. Allman remarked that in by far the greater number of plants the protoplasm of most of the cells which are exposed to the sunlight undergoes a curious and important differentiation, part of it becoming separated from the remainder in the form usually of green granules, known as chlorophyll granules. To the presence of chlorophyll is due one of the most striking aspects of external nature—the green colour of the vegetation which clothes the surface of the earth; and with its formation is introduced a function of fundamental importance in the economy of plants, for it is on the cells which contain this substance that devolves the faculty of decomposing carbonic acid. On this depends the assi-

milation of plants, a process which becomes manifest externally by the exhalation of oxygen. Now, it is under the influence of light on the chlorophyll-containing cells that this evolution of oxygen is brought about. The recent observations of Draper and Pfeffer have shown that in this action the solar spectrum is not equally effective in all its parts; that the yellow and least refrangible rays are those which act with most intensity; that the violet and other refrangible rays of the visible spectrum take but a very subordinate part in assimilation; and that the invisible rays which lie beyond the violet are wholly inoperative.

In thus acknowledging the labours of Draper and Pfeffer, Dr. Allman forgot the previous researches of Mr. Robert Hunt, F.R.S., who investigated the subject forty years ago. Dr. Allman, however, in a letter to Mr. Hunt, observes, "I have been refreshing my memory of your researches by reading your published account of them, and their completeness and conclusiveness render my regret the greater that I had not given them the recognition they so well merit." The results of Mr. Hunt's "Researches on the Influence of the Solar Rays on the Growth of Plants" were described to the British Association in 1842 and 1846, and are given in his "Researches on Light."* In his history of the progress of the inquiry, he refers to Dr. Priestley's experiments in 1779. These researches, which showed that carbonic acid was absorbed by the plant, that under the influence of light it was decomposed, and that its oxygen was again liberated, were confirmed by the experiments of several naturalists and chemists, including Senebier, Ingenhousz, DeCandolle, Saussure, and Ritter. The general result of the investigations on the chemistry of vegetation up to this point was, Dr. Hunt observes, that light was essential to healthful vegetation, but that the decomposition of the carbonic acid by the plant took place more decidedly under the influence of the most refrangible range of the spectrum than of those which possessed superior illuminating power. In 1801 Labillardière communicated to the Philomathic Society his discovery that light was necessary to the development of pores in plants; and about the same time Victor Michellotti announced that light has a decided action on those germs which are exposed to it,—that this action is prejudicial to them, and it manifests its action by retarding their expansion if the light be weak or a deflected light, or by total

* Researches on Light in its Chemical Relations, embracing a consideration of all the Photographic Processes. By Robert Hunt, F.R.S. Second Edition. London: Longmans. 1854.

extinction of their life if it be very intense, as that which comes directly from the sun. M. Macaire Prinseps observed that sheltering leaves from the action of light prevents their change of colour in the autumn: that if the entire leaf was placed in the dark, it fell off green; if only a part, the rest of the parenchyma changed colour, and the covered portion retained its original colour.

Mr. Hunt's own experiments extended over seven years; they were made at every season of the year, and the localities in which they were carried on were changed from the south-western extremity of the kingdom to the neighbourhood of the metropolis. The problem he wished to solve was the proportion and kind of influence exerted by light, heat, and actinism in the various stages of vegetable growth. The experiments were made under the action of those radiations which had permeated variously coloured media, such as tinted glass and coloured transparent fluids. We should like, did space permit, to refer to the many precautions taken in order to render the experiments exact and conclusive. We can, however, only give the results, referring our readers to Mr. Hunt's own account for further particulars of his observations. These results are as follow:—

1. Light prevents the germination of seed.
2. Actinism quickens germination.
3. Light acts to effect the decomposition of carbonic acid by the growing plant.
4. Actinism and light are essential to the formation of the colouring-matter of leaves.
5. Light and actinism, independent of the calorific rays, prevent the development of the reproductive organs of plants.
6. The heat radiations corresponding with the extreme red rays of the spectrum facilitate the flowering of plants and the perfecting of their reproductive principles.

In order to ascertain the exact conditions in which the luminous actinic and calorific principles exist, Mr. Hunt made frequent examinations of the condition of the solar radiations. He found that in the spring the actinic principle is most active, and as compared with light and heat it is considerably in excess. As the summer advances the quantity of light and heat increases relatively to the actinic principle in a very great degree. In the autumn light and actinism both diminish, and the calorific radiations are relatively to them by far the most extensive.

The term *light* is here used to express all those rays of he spectrum which are visible to a perfectly-formed human eye; by *actinic principle* is meant the principle to which the phenomenon of chemical change under solar influence belongs; and by *calorific radiations*, not merely those effects which are traceable by any thermometric instruments, but also those which we can detect by the protection from change produced by a class of rays existing near the point of maximum heat in the spectrum. In the spring, when seeds germinate and young vegetation awakes for the repose of winter, we find an excess of that principle which imparts the required stimulus; in the summer this exciting agent is counterbalanced by another possessing different powers, upon the exercise of which the structural formation of the plant depends; and in the autumnal season these are checked by a mysterious agency, which we can scarcely recognise as heat, although connected with thermic manifestations upon which appears to depend the development of the flower and the perfection of the seed."

The phenomena which the prolonged action of sunlight produces on vegetation in high latitudes are recorded by M. J. A. Broch, in a work recently published.*

The farther we go eastward from the Gulf Stream the more severe is the climate, even though the degree of latitude be the same. Thus Scandinavia and Finland possess an exceptionally mild climate, considering their high polar altitude. Indeed barley and oats will ripen in the most northern districts of Norway, Sweden, and Finland, and immense forests are met with; whilst in Iceland, Greenland, and the Polar confines of Russia and America, the earth is bare and sterile, and there are eternal snows. The cause of these advantageous climatic conditions is to be attributed to the enormous mass of warm water and hot air which the Gulf Stream brings down from the Equatorial region to the coast of Norway, which coast it approaches between 60° and 61° of latitude. This circumstance, together with the difference in the geological formation of the various northern countries of Europe, naturally lead to certain dissimilarities in the respective climates of these countries. Comparing Norway and Sweden, for instance, in the former the sun is moist, cloudy, and the quantity of rain considerable, the winters mild and the summer cold; while in Sweden the sun is brighter, the

* Le Royaume de Norvège et le Peuple Norvègien, par J. A. Broch, Ancien Ministre de Norvège.

air drier, the quantity of rain less, the winters are cold and the summers hot. The isothermic line passing through the places whose mean temperature is zero,—skirting in Norway the chain of mountains and the sea coast from the North Cape, embracing also the central part of that country between the 60th and 63rd parallels—begins in Finland at the 66th degree of latitude, and rises rapidly to the north, forming a curve which encloses the elevated lands of the interior between the Gulf of Bothnia and the Arctic Sea, so that not only the countries situated south of that parallel, but also those which slope towards the Arctic Ocean and are submitted to the salutary influence of the Gulf Stream, have a mean temperature above zero. Of all the countries situated in the same latitude as Finland, the Scandinavian peninsula alone enjoys a milder climate. European Russia is much colder, and the climate of Asiatic Russia still severer. The neighbourhood of the sea and the abundance of lakes—in the number of which no country in Europe, or perhaps in the world, can compare with Finland—cause a tolerable quantity of rain to fall, and render the climate somewhat humid.

With regard to the action of prolonged solar light on the vegetation common to all those countries, Dr. Schübeler, of the University of Christiana, has demonstrated that the seed of corn or other plants obtained from the northern regions ripens more quickly than that produced in the more southern countries. In the regions of the extreme north, where grain crops are uncertain in their yield, owing partly to the elevation of the land above the level of the sea, the seed corn of the north is always used in preference to any other. It is not less true that the various kinds of grain and vegetables cultivated in the northern regions yield better and are much richer in carbo-hydrates than the varieties cultivated more to the south. The colour, moreover, is deeper—a phenomenon which applies also to all trees and plants. Foreign botanists visiting Norway, and the other countries of the extreme north, in summer, are astonished at the fresh dark green of the foliage and the bright colours of those flowers which grow both in northern and southern climes; and as this richness of colour increases regularly with the latitude, trees and plants have at first been considered as new varieties. The leaves of trees grown in the north are larger even when the seed has been brought from more southern countries. M. Schübeler has likewise proved that the aroma of all kinds of plants and fruits, both wild and cultivated, increases as the north is

approached. Ordinary vegetables and herbs grown in high latitudes have a far more aromatic taste than those grown in more southern countries. The meadow cumin (*Carum Carvi*) is an example of this fact: grown at Christiana it contains 5·8 per cent of volatile oil, whilst that cultivated in Germany and Central Russia contains only from 4·0 to 4·8 per cent. But this large development of aromatic essence is not always considered an advantage; for instance, the tobacco plant grown in Norway or other northern countries contains, it is said, too much nicotine. In proportion, however, as the aroma increases with the latitude the saccharine substances diminish: the berries and fruits of the north are less sweet than those which are cultivated or grown wild in the more southern parts of those countries. Consequently whilst Norway as well as Sweden, and even Finland, produce the most delicious apples, the pears are not sufficiently sweet.

These facts, as well as the rapid growth of vegetation in the northern regions, are attributed to the prolonged action of solar light. Indeed at Christiana, at the summer solstice, the sun remains below the horizon only 5 h. 17 m.; at Froudheim, 3 h. 34 m. At Bodô, the chief town in Nordland, the sun does not descend below the horizon from the 2nd June till the 11th July; at Tromsô, from the 20th May to the 24th July; at Hamerfest, the chief town of Finmark, from the 15th May to the 29th July. On the other hand, the centre of the sun does not appear above the horizon at Bodô from the 14th to the 28th December; at Tromsô, from the 25th November till the 16th January; and at Hamerfest, from the 20th November to the 21st January.

It is not surprising that barley, potatoes, and many other plants and vegetables ripen in the most northern latitudes, seeing they are exposed to a considerable amount of heat during two or three months of the year. In those regions where the sun hardly descends below the horizon in summer, there is no night, only a short twilight; the growing plant therefore enjoys permanently, and without interruption, the heat and light which it requires.

III. TECHNICAL EDUCATION IN ENGLAND, FRANCE, AND GERMANY.

THE City of London Guilds and other corporate bodies seem at length to be convinced of the absolute necessity of adopting some measure for the advancement of technical education in England. As far back as the Paris International Exhibition of 1867 our English masters and workmen awoke to the fact that the leading position which we had formerly occupied as makers of the world's goods was being endangered by the talent and enterprise of foreign nations. The first note of alarm was sounded by Dr. Lyon Playfair, in a letter addressed to Lord Taunton, the Chairman of the Schools Inquiry Commission then sitting. The aim of this communication was to enquire whether England was really losing her high position in those industries which involve the application of scientific knowledge to production, and, if so, whether this retrogression was due to our comparative backwardness in the diffusion of a knowledge of applied science amongst the working classes. The British Commissioners appreciated the warning at its proper value, and, taking advantage of the presence in Paris of some of the most eminent British men of science of the day, they consulted them on the subject, the result being that, with scarcely a single dissentient voice, they affirmed that the lack of technical education on the part of British masters and workmen was slowly, but surely, undermining the position of Great Britain as mistress of the industrial arts.

Speaking generally these salutary warnings have been neglected, although in some few isolated instances they have been duly acted upon. These praiseworthy efforts have for the most part been the work of individuals, and as such have only wrought good in particular localities, anything like combined action being entirely wanting.

Amongst the latest utterances on this vitally important subject, the paper on "Apprenticeship Schools" read by Prof. Silvanus Thompson before the British Association at Sheffield, and just republished in pamphlet form,* and the Address of Prof. Ayrton at the opening of the City and Guilds of London Institute,† are the most striking. The

* Apprenticeship Schools in France. By SILVANUS P. THOMPSON, B.A., D.Sc., F.R.A.S., Professor of Experimental Physics, University College, Bristol. London: Hamilton, Adams, and Co.

† The Improvements Science can effect in our Trades and in the Condition of Our Workmen. By Prof. W. E. AYRTON.

gist of these able contributions to our knowledge of the subject is that our present system of apprenticeship is utterly rotten, and must speedily be replaced, under the penalty of seeing the whole of our trade with foreign nations gradually drift away from us. During the last half century apprenticeship, as it was understood by our forefathers, has ceased to exist except in name. The master of the present day, unlike his predecessors, seeks his own benefit instead of his apprentice's, and looks more to what he can make out of him than what he can teach him. A boy of fourteen enters a workshop willing and anxious to learn his trade; for the first year or so he finds himself in the position of a mere errand-boy, or at any rate the servant instead of the pupil of his superior. As soon as another apprentice can be found to do his drudgery he is set to some particular branch of work, and if the shop be a large one he will very probably be kept at it till the end of his term. He is placed under a workman from whom he learns but slowly, seeing that his teacher, being constantly employed on his own work, has but little time to teach him,—the evil reaching its highest point in places where piecework is the rule. It is no one's duty to teach him, and, as it formed no part of the contract between employer and employed, the journeyman very justly refuses to expend any very great portion of his time in instructing his master's apprentice in the secrets and mysteries of his handicraft. As for the master, the boy receives no help from him, even supposing that he is competent to teach him. He consequently picks up his knowledge of one small branch of his trade in an unintelligent and desultory manner, and leaves the workshop at the end of seven years capable of doing only one thing, and that by rule-of-thumb, just as his shopmates have done before him. How differently things were managed in what may truly be called the good old days of apprenticeship! In those times the master was also a workman, and laboured at his craft. He had learned every branch of it, and understood it so thoroughly as to be able to teach it to others. Capital and steam have together created gigantic factories, and the old domestic workshop—in which each worker formed part of a kind of family—gradually became the exception; the master craftsman became the mere employer, and the apprentice the boy worker.

The connexion between the depression of trade in skilled industries and the question of proper technical education, as well as the hopelessness of attempting to galvanise the old system of apprenticeship into life, is well pointed out by Mr.

George Howell in the "Contemporary Review" for October, 1877.

The question now is, what modern substitute for the old system can be adopted to the wants and wishes of the nineteenth century? Prof. Thompson's investigations happily enable us to lay before the reader the actual results of certain experiments recently made in France with a view to organising a new system of apprenticeship that shall be more in accordance with the social conditions of the present day. These results prove that the systematic instruction of apprentices is possible in several different ways; that apprenticeship schools afford a most satisfactory way of attaining this result; and, lastly, that the new system solves the problem involved in the decay of the old apprenticeship. The problem to be solved, stated briefly, is this:—How to give artizan children the technical training and scientific knowledge which their occupation demands, without detaining them so long at school as to give them a distaste for manual labour. The problem may be solved in four ways, all of which have been tested:—

First. We may apprentice children at an earlier age than at present, making it obligatory that all through their apprenticeship they shall every day have a certain number of hours of schooling in a school attached to the workshop.

Secondly. The children may be kept at school for a longer period, on condition that they shall pass a certain amount of time in a workshop attached to the school.

Thirdly. We may organise a school and workshop side by side, an equal number of hours being devoted to manual labour and study.

Fourthly. We may send the children for half the day to the existing schools, and the other half to work half-time in the workshop or factory.

The first of these plans strongly commends itself to our attention, for the knowledge imparted in the school could be correlated to the work done in the factory, to the manifest benefit of both the employer and the employed. This system has been tried in France for the last thirty years, and the establishment of MM. Chaix and Co., the French Railway Guide printers, may be cited as a type of the whole. MM. Chaix's typographical school—for such it really is—has been in existence for seventeen years, and has

supplied nearly a hundred able workmen to the firm itself, and the few who have left have found exceptionally good situations. The apprentice is bound for four years, the employers guaranteeing him a place when he is out of his time. They are divided into two classes, compositors and printers. Close to the composing- and press-rooms there is a school-room, where the apprentices of both classes spend a couple of hours daily, either in improving their knowledge of the three R's or in going through a technical course of typography, including grammar, writing and composition, reading and correcting proofs, the study of the different kinds of type, and so on. They are also taught to read and set up in type Greek and Latin, without any attempt to instruct them grammatically in these languages; and they are taught the rudiments of English and German. Lastly, there is a course on such subjects as the history of typography, or mechanics, physics, and chemistry, as far as they apply to printing machinery and processes. During the three years the apprentice compositors receive from 5*d.* to 2*s.* per day, and the printer apprentices from 7½*d.* to 3*s.* 8*d.* At the end of the term most of the apprentices prefer to remain in the employment of the firm, and can then earn from 3*s.* to 6*s.*, according to their ability. Great pains are taken to systematise the teaching. The compositor apprentices are set to work under the direction of a foreman whose chief business is to instruct them, and not to work for his own or his employer's benefit: he is, in fact, a professor of printing, just as Professor Thompson is a professor of Physics.

MM. Chaix's establishment, it must be understood, is only one of over two hundred similar schools in different parts of France, in which a similar system of instruction is given in the manufacture of optical instruments, shirts, jewellery, paper, Italian paste, ribbons, calicoes, plate glass, silks, bookbinding, and a dozen other branches of trade.

A great impetus has been given to this kind of apprenticeship schools by the passage of a law, in 1874, forbidding the industrial employment of children under 12, except they receive two hours schooling per day; nor may children over 12 and under 15 be employed for more than six hours per day, unless they have finished their elementary education, their employers being made personally responsible for carrying out these regulations.

In the school of M. Soufflot, a jeweller, the character of the instruction is purely technical. The success which has attended the "school on the workshop system," as Professor Thompson aptly calls it, must not only be extremely grati-

fying to all who have the cause of technical education at heart, but it must also prove to the attentive observer that, being the most natural, it will eventually become the best system of all.

The second type of school includes those in which systematic instruction in one or more handicrafts is given to boys who are still going on with their elementary instruction. There appears to be one school of this sort in Paris, which is carried on most successfully as far as it goes, only about 12 per cent, however, of the pupils receive manual instruction. They work alternately at carpentering, wood-turning, forging, filing, chipping, and metal-turning for two years; after which they specialise their work. They also receive instruction in modelling and technical drawing, and in the summer they visit the neighbouring factories. On the completion of the preliminary two years they are draughted off into one of the three special workshops in which modelling and carving, carpentry and wood-work, and iron- and metal-work are carried on under the superintendence of master-workmen who have made the teaching of their various crafts a special study. One of the disadvantages of this type of school is, that the instruction given is professedly only preparatory to, and not a substitute for, an ordinary apprenticeship. In its favour it must be conceded that it shortens the long and useless years of apprenticeship, and thus helps the young worker to become a bread-winner.

The third system is where the school and the workshop are placed side by side, so that the hours given to study should be co-ordinated with an equal number of hours of manual instruction. This type of school Prof. Thompson thinks is the *apprenticeship school* of the future. France affords two good examples of this class; one the Paris Municipal School of Apprentices, where several distinct trades are taught; and the Besançon Municipal School of Horology, where clock and watch making alone are taught. Taking the Paris school first, we find that the apprentices are only admitted between the ages of 13 and 16. They must also have a certificate showing that they have completed their elementary education, or else undergo an examination. In comparison with schools of the second type a larger amount of time is devoted to the workshops, which are here much more extensive and complete. The course is a three years' initiation into the handicraft taught, and the majority of the pupils leave the school able workmen. The trades in which direct instruction is given are those of the carpenter, wood-turner, pattern-maker, smith, fitter, and metal-burner.

That the school turns out excellent workers may be judged from the fact that the average age of the pupils who left the school in 1877 was 17½ years, and their average earnings in the places they had obtained was 3*s.* 1½*d.* per day, one boy of 17 getting as much as 5*s.* 4½*d.* per day as a smith. The instruction is entirely gratuitous, and the whole of the necessary tools, machines, books, &c., are supplied by the Municipality. The system pursued in this school appears to be of the very highest order, and should serve as a model for all future schools of the kind. The Besançon School of Horology is managed on similar principles, and is a striking success. The school is managed and supported entirely by the Besançon Municipality. In addition to instruction in every branch of horology, the apprentices receive lessons in their own language, arithmetic, algebra, geometry, physics, chemistry, mechanics, and drawing, in so far as they relate to horology.

The only system remaining for consideration is that of half-time schools; the system has, however, been almost discarded in this country, and has only been partially tried in France. One radical defect in it is, that there is no correlation between the work done in the factory and the information imparted by the schoolmaster; the whole of the pupils, whether they are intended to be mechanics, dyers, or printers, all receive the same kind and quantity of instruction.

So much for the good work that is being done in France, which of all European nations is certainly in the van with regard to lower technical education.

In September last Prof. Thompson visited Germany in compliance with the advice of Mr. Mundella, who, in criticising his paper at the British Association, placed the German technical schools above the French. Prof. Thompson paid visits to the Polytechnicum and Weaving Schools at Chemnitz, these being the special establishments pointed out by Mr. Mundella, and found, as he expected, that although the higher technical training schools in Germany were superior to those elsewhere, they could show nothing in any way equal to the Paris Municipal Apprentice School described above.

Prof. Thompson's investigations have been so thorough, and lead to such practical conclusions, that they should receive the serious consideration of those whose business it will be to organise either national or local systems of technical education.

The movement of the City Companies has resulted in the setting aside annually of £15,000 for the promotion of tech-

nical education, and there has been duly constituted "The City and Guilds of London Institute for the Establishment of Evening Classes for Technical Education, or the Application of Science to Industry." Twelve lectures on "Some of the Practical Applications of Electricity and Magnetism," by Mr. W. E. Ayrton, A.M., Inst. C.E., and twelve lectures on "The First Principles of Chemistry," by Prof. H. E. Armstrong, Ph.D., F.R.S., are now in course of delivery. Subsequent courses of lectures on "The Elementary Principles of Mechanics exemplified in our Clocks and Watches," on "The Applications of the Laws of Heat to the Steam and other Engines, and on "Inorganic Chemistry with especial reference to its Technical Applications," have already been arranged.

We trust this example will be followed in our large manufacturing towns, and that when the best system of imparting technical education has been determined, no red-tapeism will hinder it from being speedily and universally adopted. England will then soon regain her former position. Even the Japanese have, as Mr. Ayrton remarks, set us an example that our ambition should lead us to emulate. There has grown up, in the very midst of a people who a few years ago were almost in a state of slavery, a technical college, with its staff of carefully chosen English professors, with its laboratories, class-rooms, museums, libraries, and workshops, costing for maintenance an annual sum of £12,000. To study at this college neither money nor position is necessary; ability and a desire for knowledge are the only qualifications.

IV. ACCIDENTS RESULTING FROM THE HEAT OF THE COMSTOCK MINES.

IN the "Journal of Science" for March last we gave an abstract of a paper on "The Heat of the Comstock Mines," by Prof. John A. Church. The heat in the lower levels of these mines appears to surpass in intensity that of any other mines in the world. Prof. Church's explanation of the phenomena supposes the existence of a cold, and what may be called a burnt out, layer of rocks, extending 1000 feet below the surface; a zone of hot rock

still in active decomposition, which has been found to exist for a depth of about 1500 feet or more, and doubtless extends thousands of feet farther; and, finally, a mass of cold rock at a great depth, which has not yet begun to decompose. He refers the high temperature not to the internal heat of the earth, nor to the residual heat of the rocks, which were once melted, but to chemical action now maintained in the erupted rocks. This action is not a combustion, but the chemical alteration of the felspathic minerals of the propylite and other rocks, the peculiar bands of hot and cold rocks which Prof. Church describes, being layers of rock in which decomposition has been delayed and hastened.

Prof. G. F. Barker, who has also visited the mines, concludes,* on the other hand, that the heat is a hot-water heat, and that the waters are heated mechanically by those continuous movements of the country so plainly shown both in the mines and at the surface. But Prof. Church replies that although the Comstock discharges four and a half million tons of water yearly, not 1000 feet out of the 12 miles of linear excavation made every year are in ordinarily wet ground.

The object of this present article is not, however, to discuss the cause of the heat of the Comstock Mines, but to draw attention to the large percentage of accidents resulting from this intense heat. At a recent meeting of the American Institute of Mining Engineers, Prof. Church reviewed, at considerable length, these accidents and their relation to deep mining. From the report in the "Scientific American" we learn that during the twenty-two months preceding May, 1879, there were 101 accidents, killing 53 persons and wounding 70 others. These accidents are classified as follows:—(1) Falls of rock, timber, &c.; (2) Tramming; (3) Effects of heat; (4) Falls of men; (5) Explosions; (6) Hoisting apparatus; (7) Overwinding; (8) Miscellaneous.

In several instances miners have been fatally scalded by falling into the hot mine waters, which exhibit temperatures rising to 158° F. The most remarkable casualties, however, are due to the killing effect of labour in the hot and steaming atmosphere. The proportion of fatal casualties is larger in this class than in any other, being 73 per cent; and from the peculiar mental effects of the heat it is highly probable that it may be the real cause of many mishaps, which under other circumstances would be ascribed to culpable blundering.

On the 1900 level of the Gould and Curry mine a drift

* See Letter by G. F. LESLEY in Nature, vol. xx., p. 168.

was run along and quite near to the black dike, one of the hot spots of the mine. At a spot where the thermometer marked at times 128° F., Thomas Brown fainted while at work. When taken to the surface and revived he was found to have completely lost his memory. He could not tell his name or where he lived, and had to be dressed and taken home by his friends. The newspaper which recorded the occurrence said that such sudden loss of memory from overheating was quite common in the mines, and suggested that the fact might furnish an explanation of the walking off into fatal winzes and chutes by experienced miners, seemingly with deliberate intention.

A frequent accident in these mines is fainting in the shaft while the cage is rising to the surface. The faintness is always felt immediately upon reaching the cooler air, 100 or 150 feet from the surface, where there is usually a side draught through some adit. This happens so often that a man who has been working in a hot drift is never allowed to go up alone. Long habitude to the heat is no safeguard against this danger, and serious accidents have occurred in this way.

Among minor casualties, Mr. Church mentions one which happened to Mr. Sutro, in the Sutro Tunnel, before it made a connection with the Savage mine. After spending some time in an air temperature of 110° F., Mr. Sutro went to the air-pipe to cool off. He stayed so long that the miners told him to get away from the pipe and let them have air. He did not move, and when they tried to stir him up with the handles of their shovels they found him unable to move. He had lost all volition, and had to be taken out on a car.

The graver results of overheating include insanity and death. The death of a carman on the 1400 level of the Caledonia mine, Gold Hill, March 11, 1878, is a case in point. He had been idle for six months, and that morning he was working his first shift. At an early hour he rushed into the station of the 1400 level, and reported that the wheels of his car were smashed. The station-master returned with him to his car, and found it all right. There was evidently something wrong with the man, and he was taken to a cooling place. Here decided mental aberration was discovered, and the man, firmly lashed to the cage, was hoisted to the surface, where he fainted at once and died in a few minutes. In this case the heat was only about 90° F.

In another case a miner died from cramps, attributed to

heat, but which may have been due to drinking ice-water; and another death is charged to a cold taken while cooling off after being partially overcome with heat. Though contrary to the rules of outside hygiene, the miners resort to copious draughts of ice-water or to exposure to strong cold air currents for recovery from overheating, and usually with impunity. The cold air cooling is considered the safer method; but to gain time Mr. Church commonly chose the ice-water, and never felt any ill effects from it. With several thousand cases a day of rapid cooling off by one or the other of these methods, it is surprising that fatal consequences have been so infrequent.

The next case illustrates the violent effects which excessive heat may have upon a person not accustomed to it: —"On Friday, October 11th, 1878, John McCauley went to work for the first time in the Imperial Mine. He was cautioned against over-exerting himself in the extreme heat of the lower levels. He replied that he thought he was strong enough to stand anything, and paid no attention to the advice. At half-past two in the afternoon he was brought to the surface in an unconscious state, and died the next morning at half-past ten o'clock."

Two other cases very similar to this have occurred in the Imperial within a few years. This mine is excavated in one of the hot spots of the Comstock.

The hot drift on the 1900 level of the Gould and Curry is the scene of the most serious of these casualties due to heat. Five men were sent there in June, 1878, to load a donkey-pump on a car. The work was so exhausting that when the pump caught on a plank they were not able to move it. They seem to have been in a state of mental confusion, but felt that they could not remain longer. Starting up a winze which connects with the 1700 level one man fell on the way, and the others were afraid to stop to help him, but pressed on, reaching the 1700 level in half an hour from the time they left it. They were very confused and nearly speechless, and hardly realised what had occurred. Three men went down to the rescue, and found the fallen man still alive. Clearing the pump they got into the car and signalled to hoist, but on the way up the winze the man they had gone to rescue reeled and fell off. The car was stopped at once, but he was jammed between it and the brattice so fast that the others left him and went for help. They all gave out, two half-way up, and the other just as he reached the 1700 level, where a friendly hand pulled him up. A new rescue party went down and found two men

dead, and the third died soon after. The shift boss reports that "the accident was due solely to the heat, as the air is good enough and pure enough, barring the heat." The winze was not an abandoned one, but in daily use. A heavy volume of steam is reported to rise through it from the 1900 level, the temperature of which, at the time of this accident, is given at 128° F. Mr. Church gathers from the detailed account that the death of the men is possibly attributable to the fact that when the miner fell off the car the latter was stopped in a place that was hotter than the rest of the winze.

It is to be regretted that no adequate studies have been made upon the precise physiological phenomena presented by death under these circumstances. The legal requirements are satisfied when it is proved that the casualties are due to heat.

V. ARE THE CHEMICAL ELEMENTS SIMPLE BODIES?

THE researches which have been made in the various branches of physical science during the last few years have many of them been of unusual importance. Some—the telephone and microphone, for instance—have already resulted in the invention of instruments of great practical utility, while others have opened up new fields for research, and bid fair to effect a complete reversal of the generally-accepted notions concerning Matter. As Prof. W. B. Rogers remarked, in his Presidential Address at the 1879 Meeting of the New York Academy of Sciences—"In all branches of discovery we seem to be catching the clews of far-reaching thought that stretch out where as yet no man's foot has trodden. The recent developments in Chemistry, through the agency of the spectroscope, and the effects of heat in dissociation, have suggested, if they have not proved, that a number of the substances hitherto regarded as elements are hereafter to be regarded as compound. The investigation of the laws of chemical action following out the suggestions made at the beginning of the century by

the great chemist Berthollet, in regard to the influence of man on chemical reaction, seems to promise most important discoveries in chemical statics and the possibility of applying mathematical reasoning and formulæ to chemical activities. The marvellous series of experiments presented recently by Crookes, in which have been exhibited the wholly unexpected phenomena which he has described under the designation of what was first referred to by Faraday as a fourth form of matter, which this illustrious experimentalist called radiant matter, seemed to open up a field of research and speculation until now wholly undreamed of. In truth, the active scientific workers have now been brought by their refined and novel researches to touch the near extremities of innumerable lines of thought and investigation, stretching out into unknown regions, whose exploration is to occupy the activity and reward the labours of a coming generation."

In discussing the question whether or not the study of the spectrum has thrown, or is likely to throw, any light on the ultimate constitution of matter, Dr. Balfour Stewart* recently referred to the fact that Prout first pointed out that the atomic weights of the so-called elements are very nearly all multiples of the half of that of hydrogen, so that the various elements may possibly be looked upon as formed by a grouping together of certain atoms of half the mass of the hydrogen atom. A most remarkable series of experiments was conducted by M. Stas to test this doctrine. He came to the conclusion that the atomic weights of the various elements were not precisely multiples of the half of that of hydrogen, there being greater differences than could possibly be accounted for by errors of experiment. But Dr. Stewart, calling attention to the great difficulty of obtaining substances absolutely free from all impurity, does not admit that Stas's researches settled the point in the negative, and points to the spectrum as a likely means of throwing some light on the question. Now Mr. Lockyer's researches tend to show that at sufficiently high temperatures the so-called chemical elements, or at all events some of them, are compound bodies. These researches were not undertaken with the view of decomposing the elements. Mr. Lockyer was preparing a map of the solar spectrum on a large scale, and the work included a comparison of the Fraünhofer lines with those visible in the spectrum of the vapour of each of the metallic elements

* Nature. "On some Points in the History of Spectrum Analysis: an Address to the Natural Philosophy Classes at Owens College, Manchester, November, 1879."

in the electric arc. (The complete spectrum of the sun, on the scale of the working map, will be half a furlong long: in mapping the metallic lines and purifying the spectra more than 100,000 observations were made, and about 2000 photographs taken.) The final discussion of the complete photographs of the spectra of the metallic elements compared with the spectrum of the sun led to the results which are exciting so much interest at the present time.

There are certain lines in the spectra of each element which appear long and thick; and it has been found that while such a line, for instance, is exceedingly prominent in some one element, other elements appear to possess it, only not nearly so prominently. Mr. Lockyer argued from this, that on the assumption that the elements are truly elementary, the line in the other elements was caused by traces of impurity. He has, however, found that there are coincidences in the lines of metallic spectra of two perfectly distinct kinds. There are coincidences of lines which are not the prominent lines of any one spectrum, and they give no signs of that variability of brightness that might be expected to characterise lines due to impurities: these lines he has called basic lines. In Mr. Lockyer's own words, "The temperature of the sun and the electric arc is high enough to dissociate some of the so-called chemical elements, and give us a glimpse of the spectra of their bases, just as in the case of the various salts of calcium there is a temperature which just allows us to get a glimpse of a line indicating the metal calcium common to them all."

To determine whether these basic lines varied in their behaviour from other lines of spectra taken at random, Mr. Lockyer had recourse to the spectrum of sun-spots. The sun is surrounded by an enormous atmosphere which is supposed to contain the vapours of such metals as iron and magnesium; but whether this be so or not, Mr. Lockyer argued that the atmosphere would certainly be hotter at bottom—nearer the photosphere—than higher up, and that the spectrum of the atmosphere close to the photosphere would differ from that of any higher region, and therefore from the general spectrum of the sun. In observing the spectrum of a sun-spot, or a prominence, the spectrum of an isolated mass of vapours in the hottest region open to inquiry can be determined, and Mr. Lockyer found that this spectrum differed greatly from the general spectrum of the sun. The whole character of the spectrum of iron, for instance, is changed when we pass from the iron lines seen among the Fraünhofer lines to those seen among the spot

and storm-lines. As therefore the spectra of spots and prominences are from the hottest region of the sun, Mr. Lockyer employed them for testing these basic lines. The result has led him to conclude that their appearance in two or more spectra is dependent solely upon high temperature. The basic lines are more prominent in the spectra of spots than in the spectrum of the sun; they are, moreover, more prominent at epochs of sun-spot maximum than during times of minimum. The statement, then, that the spectrum of each element consists only of lines special to that element, is found to be insufficient when the highest temperatures and the greatest dispersions are employed.

A clearer conception of what is meant by the so-called elements being split up at a very high temperature will be gathered from the following illustration, given by Dr. Balfour Stewart:—"If we apply a very powerful source of electricity, we obtain certain peculiar lines from the vapour of calcium. Now if we could catch hold of and segregate —put into a box, as it were—all these minute entities that give us this suspicious line at a high temperature, and, further, if we could keep their high temperature up, I think it is probable that we might obtain something which is not calcium, or, at any rate, something simpler than the molecule of calcium as this appears at lower temperatures. But we are not yet able, and perhaps we may never be able, at an ordinary temperature, to present the chemist with some other substance derived from calcium, which is not calcium."

Much, of course, remains to be done before Mr. Lockyer's views will be universally accepted. The indecomposable character of the bodies which we have hitherto considered elementary has for a long time been considered doubtful. Mr. Lockyer, however, is the first to come boldly forward with experimental proof. What the final result of the discovery will be we cannot foretell. A physical problem, as Dr. Stewart says, begins like a rivulet. At its first introduction it is small and seemingly unimportant; constantly, however, as it winds along it receives accessions from various quarters, until at length it becomes a mighty river that is finally merged in the unfathomable ocean. This course is followed by all such problems. Each begins small, grows broader, and will finally bear us on to the unknown if we trust ourselves to its guidance.

VI. DARWINISM AND ARTICULATE SPEECH.

AT the Meeting of the Academy of Sciences, on the 10th November, 1879, M. Larrey referred to a work written by Dr. Frederic Bateman, of Norwich, on the subject of Darwinism. In the course of his remarks M. Larrey said that Dr. Bateman combats Mr. Darwin's assertion that a difference between man and animals is only one of degree, and not of kind. He has transferred the subject of Evolution to the domain of Psychology, being convinced that hitherto naturalists have concentrated their attention too exclusively on the analogies between the body of man and that of animals, or, in other words, on the purely physical, anatomical, and material characteristics, neglecting the study of the intellectual and metaphysical attributes, which constitute an essential difference between man and animals.

Whilst admitting that man, in his purely physical nature, is closely allied to certain animals, Dr. Bateman repudiates entirely the conclusion drawn from that analogy by Mr. Darwin; for supposing the resemblance of man to an animal bone for bone, nerve for nerve, muscle for muscle, to be proved, what are we to conclude from it if it is also demonstrated that man possesses a distinctive attribute the least trace of which is not found in a brute, an attribute which establishes a gulf between the two? The author affirms that such a distinctive attribute exists in articulate speech. He examines first the doctrine of Darwinism, beginning with an exposition of the principles of Evolution as laid down by Haeckel. He then asserts that no proof exists of the transmutation of species since historic times, and cites the cases of bodies embalmed for three thousand years, and of the birds and animals carved on the ancient monuments of Egypt. He thus confirms what Flourens had already said, viz., "*The species do not alter nor pass from one to the other; the species are fixed.*"

Dr. Bateman then introduces the study of speech as an additional argument against the theory of Evolution, and explains his plan of attack on Mr. Darwin by the three following propositions:—

1. Articulate speech is the distinctive attribute of man, whilst the ape and other animals possess no such power.

2. Articulate speech is a universal attribute of man, and all the races have a language or the capacity of acquiring one.
3. The faculty is immaterial.

Dr. Bateman also discusses and criticises the views of the German neologists on Life-matter and Force, ending with some remarks on the mysteries of life itself.

VII. A REMARKABLE WATER AND GAS GEYSER.

AS early as 1833 a salt well, drilled in the valley of the Ohio, threw columns of water and gas at intervals of ten to twelve hours to heights varying from 50 to 100 feet. A number of wells in the oil regions have since then thrown water geysers, but none have attracted so much attention as one situated near Kane.

The columns are composed of mingled water and gas, the latter being readily ignited. After nightfall the spectacle is grand. The antagonistic elements of fire and water are so promiscuously blended that each seems to be fighting for the mastery. At one moment the flame is almost entirely extinguished, only to burst forth at the next instant with increased energy and greater brilliancy. During sunshine the sprays form an artificial rainbow, and in winter the columns become encased in huge transparent ice chimneys.

The cause of the action is thus explained by Mr. C. A. Ashburner, in "Stowell's Petroleum Reporter":—

This well is situated in the valley of Wilson's Run, near the line of the Philadelphia and Erie Railroad, 4 miles south-east from Kane. It was drilled by Messrs. Gruhout and Taylor, in the spring of 1878, to a total depth of 2000 feet. No petroleum was found in paying quantities, and the casing was drawn and the hole abandoned, since which time it has been throwing periodically—every ten to fifteen minutes—a column of water and gas to heights varying from 100 to 150 feet.

During the operation of drilling, fresh "water-veins" were encountered down to a depth of 364 feet, which was the limit of the casing. At a depth of 1415 feet a very heavy "gas vein" was struck. This gas was permitted a

free escape during the time the drilling was continued to 2000 feet.

When the well was abandoned, from failure to find oil, and the casing drawn, the fresh water flowed into the well, and the conflict between the water and gas commenced, rendering the well an object of great interest. The water flows into the well on top of the gas, until the pressure of the confined gas becomes greater than the weight of the superincumbent water, when an explosion takes place, and a column of water and gas is thrown to a great height. This occurs at present at regular intervals of thirteen minutes, and the spouting continues for a minute and a half. On July 31st, 1879, Mr. Sheafer (aid, McKean County) measured two columns, which went to heights respectively of 120 and 128 feet. On the evening of August 2nd Mr. Ashburton measured four columns in succession, and the water was thrown to the following heights:—108, 132, 120, and 138 feet.

VIII. THE TRANSIT OF VENUS IN 1874.*

THE following is a complete transcript of Mr. Hennessey's observatory notes:—"This record was obtained by means of the following agency. My friend, Mr. W. H. Cole, M.A., audibly counted seconds, and named the minutes as completed, from a large chronometer, before which he was comfortably seated, say 6 feet from the equatoreal. Baboo Cally Mohun Ghose, with paper and pencil, took up a position by my side; he mentally followed Mr. Cole's counting, and noted down the instant I made a remark, together with the words I uttered. In the absence of remarks, the Baboo noted the number of each complete minute as it was declared, a reckoning which was checked by inspection of the chronometer and otherwise from time to time, so as to render the adoption of a *wrong* minute practically impossible. Thus all that remained for me to do was to look intently through the telescope of the equatoreal and declare exactly what I beheld. We three individuals were

* "Further Particulars of the Transit of Venus across the Sun, December 9, 1874; observed on the Himalaya Mountains, Mussoorie, at Mary-Villa Station, Lat. 30° 28′ N., Long. 78° 3′ E.; height above sea 6765 feet, with the Royal Society's 5-inch Equatoreal." By J. B. N. HENNESSEY, F.R.S. Abstract of Paper read before the Royal Society, November 20, 1879.

all enclosed within the canvas walling of an observatory tent only 8 feet square, the top of the tent being removed. No sound broke the enforced stillness that prevailed; the sky was brilliantly clear, and all cause for anxiety as to clouding over, or the driving of the equatoreal, or on any other account, was completely absent; while the events in question were plainly seen to progress so gradually and deliberately that there was not the smallest occasion for hurry or confusion of any kind, nor did any occur. Unlike a solar eclipse, when every second is of the utmost importance, there was plenty of time for every purpose. Under these circumstances it was practically impossible that any blunder in recording could be committed.

Observatory Notes.

1874. December. Chronometer Time. d. h. m. s.	Greenwich Time. d. h. m. s.	Remarks made by Observer at the time.
		Ingress.
		Beautifully clear morning. No haze. Eyepiece 125. Two coloured glasses giving a neutral or bluish field. Missed the first external contact.
8 19 18 0	8 14 6 35	Venus's edge on sun boils somewhat; it is, however, distinctly visible.
20 0	8 35	Venus's outer edge, *i.e.*, against sky, distinctly visible, because of a narrow edging, or ring of light, around some 30° of that part of it farthest from the sun.
20 50	9 25	The light ring now extends around the whole of that part of Venus's edge against the sky, and is some 3″ in width; it is brightest where farthest from the sun.
22 33	11 8	The light ring against sky is well seen, and looks undeniably like Venus's atmosphere; width some 4″; definition excellent.
23 0	11 35	The light ring against the sky can be plainly traced *in continuation* around Venus on the sun, where, however, it is made visible chiefly by the *movements* occurring in it of minute bright specks, and also because it boils. The entire ring is full of these minute bright specks, which appear and disappear rapidly, dancing about with little flashes. Definition excellent.
24 28	13 3	Light ring against sky wider.
25 10	13 45	,, ,, quite distinct.
26 26	15 1	,, ,, quite bright.
28 34	17 9	Transit of Venus's dark edge across the sun's limb, *i.e.*, first internal contact.

1874. December.

Chronometer Time. d. h. m. s.	Greenwich Time. d. h. m. s.	Remarks made by Observer at the time.
		Ingress.
29 10	17 45	Transit, by estimate, of outer edge of Venus's light ring (that was against sky) across the sun's limb. No ligament or pear-drop seen, *though expected and carefully watched for.*
22 0 0	8 16 48 36	Brilliantly clear sky; light breeze from south.
32 0	17 20 36	Spectroscope set up, adjusted, and used. Slit placed across Venus's *centre* gave a black band all along the length of solar spectrum. Slit placed tangential to Venus's disk gave a faint, narrow, glimmer of light, slightly brighter than solar spectrum, instead of black band; no displacement of solar lines in glimmer.
		Egress.
		Eyepiece as before, 125. Of the two coloured glasses used for Ingress, one now changed for a red glass; field now red and less lighted than at Ingress. Definition sharp and excellent. No boiling visible around sun's limb; some boiling round Venus's lower limb, and still less around upper limb. Removed the red glass and substituted a blue one, when the boiling round Venus became quite visible. Removed the temporary substitute and restored red glass, as before, and thus watched the further progress of the transit.
8 23 9 0	8 17 57 36	About one-fourth of Venus's diameter from contact. No ligament visible.
11 38	18 0 14	About one-sixth of Venus's diameter from contact. No ligament visible.
12 40	1 16	About one-eighth of Venus's diameter from contact. No ligament visible.
15 8	3 44	Less than one-twelfth of Venus's diameter from contact. No ligament visible.
16 0	4 36	About one-twentieth of Venus's diameter from contact. No ligament visible.
16 57	5 32·6	Second internal contact.
22 0	10 36	Light ring now visible around Venus's limb against sky.
34 0	22 36	No boiling around Venus's or sun's limb.
37 30	26 6	Venus's limb against sky only faintly seen.
40 0	28 36	Light ring has been invisible for some time; was seen for only a short time after second internal contact.
44 14	32 49·6	Second external contact. No ligament visible thereafter or at any time before.

The following is an excerpt from a letter by the late Rev. H. D. James to Mr. Hennessey, who was stationed 19 miles from him to the north-west :—

"Chakatra, N.W.P., December 9, 1874.

"Through your kindness in sending me a diagram of the planet's progress across the sun's disk I had as satisfactory a view of it as was possible. My son was with me. At 6.56 we noticed the sunlight on the snowy range. Ten minutes and twelve seconds after that we saw the rim of the sun rising above the mountain which intervened between us and the horizon. We keep an eye on Mussoorie and Landour, and thought they had but two minutes' advance of us in seeing the sun. Eighteen minutes and ten seconds after our first glimpse of the sunlight Venus began nibbling at the rim of the sun. Between this and her entire entrance on to the disk was twenty-seven minutes and ten seconds; that is, we saw her external contact at 7° 14′ 10″, and her internal contact at 7° 41′ 20″. When she was about half-way on, we both noticed a fringe of white light illuminating that rim of the planet which was yet on the dark sky. When she went off we noticed the same fringe of light, but for a much shorter time, and when only about one-eighth of her had passed the sun's disk. The internal contact for departure took place at 11° 30′ 15″, and the external at 11° 57′ 25, as near as it was possible to say, for there was a sort of flickering, which rendered it difficult to fix on the precise moment of contact.

"The spots on the sun were but insignificant, in magnitude about the same as yesterday, though in position very different."

NOTICES OF BOOKS.

A Handbook of Double Stars, with a Catalogue of twelve hundred Double Stars and extensive Lists of Measures. With Additional Notes, bringing the Measures up to 1879. For the use of Amateurs. By EDWARD CROSSLEY, F.R.A.S., JOSEPH GLEDHILL, F.R.A.S., and JAMES M. WILSON, M.A., F.R.A.S. London: Macmillan and Co. 1879.

IT is said that one-fourth of the stars are multiple stars, and yet their study dates only from the time when the telescope was first used in astronomical research. Thousands of observations have since been made, and much has been written on the subject. There is, however, no convenient handbook for the guidance of students of sidereal astronomy. The present work is written in order that future students may know what stars are of especial interest, at what time observations are especially needful, and what stars have been so frequently and satisfactorily measured that for the present day they need no attention.

The book is divided into four parts. The first part is historical, and descriptive of instruments and methods; the second is mathematical; the third contains lists of measures of the most interesting double and multiple stars, with historical notes on those which are of special interest; the fourth part is bibliographical.

Part I., Chapter II., contains an excellent description of the Equatorial; the Clock, its construction and adjustments; the Observing Chair; and of the best form of Observatory. Chapter III. gives an account of the Equatorials which have been used by double-star observers. Chapter IV. is on the Micrometer; and Chapter V. describes the methods of observing, &c.

The first and second chapters of the second part give a detailed account, with a fully worked example, of determining an orbit and an ephemeris by a purely graphical construction founded on Herschel's and Thiele's methods. An example of the application of analysis to a double-star orbit already approximately known by graphical methods is given in Chapter IV. Chapter V. is on the effects of proper motion and parallactic motion; and Chapter VI. is on the mode of combining observations and determining their weight.

Part III. contains a catalogue of double stars selected as of special interest, with a list of all accessible measures.

The work is illustrated, and is written in such a simple style that the most uninitiated student will have little difficulty in mastering the subject, while it will prove a most valuable work of reference to the experienced astronomer.

PROCEEDINGS OF SOCIETIES

ASTRONOMICAL SOCIETY, *Nov.* 19.—Lord Lindsay, President, in the chair.

Prof. Adams read a paper "On the Ellipticity of Mars and its Effect on the Motion of the Satellites." He said that Prof. Asaph Hall's observations showed that the orbits of both satellites are inclined at small angles to the plane of the planet's equator. It became an interesting question to enquire whether this state of things is a permanent one. Mr. Marth had recently investigated the motion of the nodes of the orbits of the satellites on the orbit of the planet, which will be due to the disturbing action of the Sun, and he came to the conclusion that, if there is no force depending on the internal structure of Mars which modifies the Sun's action, the nodes of the orbits will be in opposition to each other a thousand years hence. But Prof. Adams argued that this motion would be materially affected by the disturbing force due to the ellipticity of the planet, which would cause the nodes of the satellites to retrograde on the plane of the planet's equator. The ellipticity of Mars is too small to be observed, but the motion of the nodes will probably afford a means of determining the ellipticity of the planet within very definite limits.

Mr. Stone read a paper "On the Evidence of a Past Connection between four widely separated Southern Stars, viz., ζ Toucani, ϵ Eridani, ζ^1 Reticuli, and ζ^2 Reticuli."

Mr. Christie read a paper by Prof. C. J. Draper "On a Photograph of the Solar Spectrum, showing dark lines coincident with oxygen lines.

Mr. De La Rue gave an account of a visit to the works of Messrs. Repsold, Hamburg, and described a conical pendulum for the driving-clock of an equatorial which was being made for Professor Winnecke, of Strasburg. The principle was similar to that of the balance-wheel and spring of a watch, for the elasticity of the rod of the pendulum was made use of instead of the force of gravity to resist the centrifugal force caused by the motion of the pendulum. Messrs. Repsold told him that when the driving weight of the clock was changed for another fifteen times as great, the variation and the rate of rotation only amounted to 0·04 per cent.

Dr. Schuster read a paper "On the Polarisation of the Corona."

The President said he had obtained an observation of Deimos at Dunecht. Mr. Christie also obtained observations of Deimos at Greenwich, made on the 4th and 18th of October.

Mr. Common stated that he had on five nights obtained observations and measures of both the satellites of Mars with his 37-inch reflector.

Capt. Noble showed two sketches of the planet Jupiter, showing the great elliptical red marking in the southern hemisphere of the planet.

CHEMICAL SOCIETY, *Nov.* 20.—Dr. Gilbert, F.R.S., in the chair.

"A Chemical Study of Vegetable Albinism (Part II., Respiration and Transpiration of Albino Foliage)," by A. H. Church, M.A. The author has proved that white foliage does not possess the power, even in sunshine, of decomposing the carbon dioxide of the air, but adds largely to the normal amount of that gas in the air, thus resembling the petals of flowers and the action of green leaves during darkness. The best results were obtained with the maple (*Acer negundo*), the holly, the ivy, and the *Alocasia macrorhiza*. The author has also studied the comparative loss and gain of albino and green foliage. White holly sprays placed in water gained, in two hours, 0·29 per cent; green holly, under similar conditions, gained 1·55 per cent. When no water was supplied the white holly lost 0·54 per cent; the green, 10·26 per cent. The author promises further work on this interesting subject. He exhibited some dry specimens of albino and ordinary leaves, the albino leaves being thinner and altogether much less substantial in their structure.

GEOLOGICAL SOCIETY.—The first meeting of the present Session was held on November 5th; the President, Mr. H. C. Sorby, F.R.S., presiding.

The papers read included one by Robert Mallet, F.R.S., "On the Probable Temperature of the Primordial Ocean of our Globe." According to the latest hypotheses as to the quantity of water on the globe, its pressure, if evenly distributed, would be equal to a barometric pressure of 204·74 atmospheres. Accordingly water, when first it began to condense on the surface of the globe, would condense at a much higher temperature than the present boiling-point, under ordinary circumstances. The first drops of water formed on the cooling surface of the globe may not impossibly have been at the temperature of molten lead. As the water was precipitated, condensation of the remaining vapour took place at a lower temperature. The primordial atmosphere would be more oblate and less penetrable by solar heat than the present, and the difference of temperature between polar and equatorial regions would be greater; so that, in the later geologic times, ice may have formed in the one, while the other was too hot for animal or vegetable life. Thus, formerly the ocean would be a more powerful disintegrant and solvent of rocks, mineral changes

would be more rapid, and meteoric agencies would produce greater effects in a given time.

A discussion ensued, in which the President, Mr. Evans, Prof. Prestwich, Dr. Hicks, Prof. Bonney, and Capt. Galton took part. In replying, Mr. Mallet said he did not suppose any part of the original crust of the globe remained at present visible at the surface. Such geological deductions as were made in his paper were only illustrative, and might be open to question. The epoch at which the phenomena occurred to which his paper referred was long anterior to the existence of either animal or vegetable life upon our globe. What he affirmed as certain was that the method he had indicated, requiring for its data a more extended experimental knowledge of the relations between temperature and pressure in aqueous vapour, and a more exact knowledge of the total volume of water now upon our terraqueous globe, affords the means of determining the temperature of our oceanic water at every period, from that of the primordial ocean to our own day.

A paper "On the Fish-remains found in the Cannel Coal in the Middle Coal-measures of the West Riding of Yorkshire, with the description of some New Species," was contributed by James W. Davis. The remains described by the author were from a bed of Cannel coal about 400 feet from the base of the Middle Coal-measures, and were chiefly obtained from this bed at the Tingley Colliery. The author described the general geological structure of the district. The following are described as new forms:—(1) *Compsacanthus triangularis*, (2) *C. major*, and (3) *Ostracacanthus dilatatus*, the type of a new genus resembling *Byssacanthus*, Agass.

Prof. R. Owen, C.B., F.R.S., read a paper "On the Skull of *Argillornis longipennis*, Owen," in which he described a fragmentary cranium from the London Clay of Sheppey, from which it was procured by W. H. Shrubsole, Esq.

Institution of Civil Engineers.—At the second meeting of the Session, held on the 18th of November, Mr. W. H. Barlow, F.R.S., Vice-President, in the chair, the paper read was on "Tunnel Outlets from Storage Reservoirs," by Mr. C. J. Wood, M. Inst. C.E. The subject was divided into the consideration of culverts in a direct line through an embankment, and tunnels round the end of the embankment as a distinct work. The author advocated the tunnel clear of the embankment, and valve-towers of masonry and iron, as the best and safest, if more costly, plan. The paper contained some remarks on the works for the supply of water to Bradford, Yorkshire, which was obtained from three districts. A High Level Supply was taken from the hills above Oxenhope; an Intermediate Supply from Manywell Springs, and a Low Level Supply from Skipton district. The high-level reservoirs afforded instances of tunnel

outlets. The Stubden Reservoir had been a cause of anxiety, the original culvert of masonry proving leaky. It had been abandoned in favour of a tunnel lined with cast-iron plates backed with concrete, terminating in a cast-iron valve-tower, erected from the design and under the superintendence of Mr. A. R. Binnie, M. Inst. C.E. The embankment was cut down, the original culvert taken out, and the embankment was then made up solid in thin layers, the new tunnel being used to run water off during the reconstruction of the work. No leakage of any description had since been noticed, the valve-tower and tunnel being water-tight. The Leeming Compensation Reservoir for mill-owners had been originally made with a circular culvert having a slip joint and iron shield where it crossed the puddle-trench. This culvert was seriously fractured by the subsidence of the bank, which was mostly on a clay foundation, and it was considered unsafe to fill the reservoir. On the suggestion of Mr. Rawlinson, C.B., M. Inst. C.E., and of Mr. Binnie, on the latter taking charge of the Bradford Corporation Water-Works, the old culvert was abandoned, and a new tunnel was substituted, similar to the one at Stubden. The original culvert was afterwards filled on the inside with concrete, and the reservoir was successfully filled with water, no leakage or disturbance having occurred up to the present time. In the case of the Leeshaw Reservoir, which was in course of construction, on Mr. Rawlinson's inspection it was resolved to abandon the culvert already cracked, and to substitute a tunnel outlet and valve-tower of cast-iron, similar to those at Leeming and Stubden: this had been successfully done, the reservoir filled, and the work had since proved most satisfactory. In two of the above cases the culverts were so damaged as to be a strong argument in favour of tunnel outlets distinct from the embankment.

Physical Society.—The first meeting of this Society for the Session 1879-80 was held on Saturday, November 8th, Prof. W. G. Adams in the chair.

The first paper read was "On an Analogy between the Conductivity for Heat and the Induction Balance Effect of Copper-tin Alloys," by W. Chandler Roberts, F.R.S. Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys published by him in June last, and the curve of Calvert and Johnston for the conductivity of heat, and, on the other hand, he showed that the induction curve does not agree with Matthiessen's curve for the electric conductivity of the same alloys. In the course of his paper Mr. Roberts expressed a hope that Prof. Hughes's beautiful instrument will enable us to determine whether the relation between conductivity for heat and electricity is really as exact as it has hitherto been supposed to be.

Capt. Armstrong exhibited a standard Daniell cell formed of a porcelain vessel with a porous partition dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc; in the other the copper plate in a solution of sulphate of copper. To use the cell as a standard, it was only necessary to connect the two liquids by a cotton string moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electromotive force.

Prof. Guthrie mentioned that Prof. Pirani, of Melbourne, in a letter to him, had signalled the fact that when a dilute acid was being electrolysed, the positive electrode, if made of iron, became incandescent below the surface of the liquid. Prof. Guthrie had found this to be true not only for iron, but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cathode or positive electrode, where oxygen was evolved, but also at the anode, where hydrogen was evolved. The incandescence appeared to him to be due rather to resistance. The author exhibited his experimental results, which he did not doubt had already been obtained by Prof. Pirani himself. The positive electrode when immersed in the electrolyte was seen to get red-hot and to wobble about. As the liquid heated the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a sputtering noise. The light was tinged with the characteristic colour of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Prof. Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acids.

November 22, 1879.—Prof. W. G. Adams in the chair.

Prof. Guthrie exhibited a new Image Retention Photometer, and demonstrated its action to the meeting.

Dr. Shettle, of Reading, read a paper on the "Influence of Heat upon certain forms of Induction Coils, considered more especially in relation to the Inductive Power which the Blood exercises on the Various Structures of the Body. The author found that when a copper and a zinc wire were insulated from each other by parchment-paper and paraffined silk, and wound in close proximity to each other, an (induced) current was indicated on a galvanometer whose terminals were connected to the neighbouring ends of the zinc and copper wires respectively, the other ends being left free. When the latter were connected across the deflection was *nil*. On raising the temperature of the two wires, by causing hot water to flow inside the coil into which they were wound, the deflection was largely increased. These experiments led Dr. Shettle to imagine that there is a similar action in the animal body. The heart is made up of nerves and muscular fibres winding spirally, and some of these wind round

each other so as to form a spiral cord, round which the blood capillaries also wind. Dr. Shettle compares these nerve and muscle bundles to the coils of zinc and copper wire in his experiments, and infers that electric currents may be induced in them as in the wires. The flow of the warm magnetic blood would also tend to produce currents in them. Dr. Shettle, further, drew attention to the fact that animals live and move in a magnetic field, and that electricity must be generated in them by their movements, internal and external.

Mr. Emmott exhibited Crossley's Form of Microphone, which consists of four short rods of carbon jointed loosely into four blocks of carbon, so as to form a square. It is used as a transmitter for telephones, and Mr. Crossley regularly transmits the services of a church with it to several hearers. Its speaking, singing, and whistling powers were successfully demonstrated to the meeting.

ROYAL SOCIETY, *Nov.* 20.—Dr. Spottiswoode, President, in the chair.

"Experimental Researches on the Electric Discharge with the Chloride of Silver Battery," by Warren De La Rue, M.A., D.C.L., F.R.S., and Hugo W. Müller, Ph.D., F.R.S., Part III. In the first part of this paper the authors describe a series of experiments to determine the potential necessary to produce a discharge in a tube, exhausted gradually more and more while using a constant number of cells in all the experiments. The tube employed was 33 inches long and 2 inches in diameter, the distance between the ring and straight wire terminals being 29·75 inches; the battery consisted of 11,000 cells. The next part of the paper deals with the potential necessary to produce a discharge between discs 1·5 inch in diameter, at a constant distance and at various pressures; the remainder being chiefly occupied with the study of the phenomena of the electric arc under various conditions of distance, pressure, and potential. The experiments were made in a bell-jar, containing the terminals, which could be gradually exhausted after having been filled with air or other gas. A remarkable phenomenon was observed on making connection between the terminals and the battery by means of the discharging key, namely, that within certain limits of pressure in the bell-jar a sudden expansion of the gas took place, and that as soon as the connection was broken the gas then as suddenly returned nearly, but not quite, to its original volume in consequence of a slight increase of temperature. The effect was exactly like that which would have been produced if an empty bladder had been suspended between the terminals, and suddenly inflated and as suddenly emptied. This is thought to be produced by a projection of the molecules by electrification causing them to press outwards against the walls of the containing vessel, this pressure being distinct from

the motion caused by heat. The appearances presented by the arc in air, hydrogen, and carbonic acid are very beautiful, and are copiously illustrated by copies, in mezzotint, of photographs and drawings. The authors conclude that for all gases there is a minimum pressure which offers the least resistance to the passage of an electric discharge. After the minimum has been reached, the resistance to a discharge rapidly increases as the pressure of the medium decreases. That the potential necessary to produce a discharge between parallel flat surfaces at a constant distance and various pressures, or at a constant pressure and various distances, may be represented by hyperbolic curves. The resistance of the discharge between parallel flat surfaces being as the number of molecules intervening between them. That the electric arc and the stratified discharge in vacuum tubes are modifications of the same phenomenon.

"Preliminary Note on Magnetic Circuits in Dynamo- and Magneto-Electric Machines," by Lord Elphinstone and Charles W. Vincent, F.R.S.E., F.C.S., F.I.C. The experiments which form the subject of this note were made in connection with an investigation as to the best form for the construction of a dynamo-electric machine, intended to furnish currents of high intensity in great quantity. The principles deduced applies equally, however, to magneto-electric machines. The authors show that electro-magnets do not lose their magnetism, as commonly supposed, immediately on cessation of the voltaic current, but that if the poles are "closed" by approximation of other magnets or armatures, the magnetism is retained for an indefinite time. A magnet 58lbs. weight could be lifted by its armature, and sparks obtained from the ends of the wires of its helix a week after magnetisation. The authors have constructed a dynamo-electric machine, in which the "closed magnetic circuit" is utilised, which they propose to describe in a future paper.

"Preliminary Report to the Committee on Solar Physics on the evidence in favour of the Existence of certain Short Periods common to Solar and Terrestrial Phenomena," by Balfour Stewart, F.R.S., and William Dodgson. In a previous Report to this Committee the authors exhibited a method of detecting the unknown inequalities of a series of observations, and gave some evidence that the temperature-range and the declination-range at Kew Observatory are both subject to the same short-period inequalities, the particular periods investigated being those around twenty-four days. In the present paper they investigate, after the method described in their first Report, the following ranges:—

I. Diurnal Ranges of Temperature of Air at—α Kew (already given); β Toronto; γ Utrecht.

II. Diurnal Ranges of Magnetic Declination, including Disturbances at—α Kew; β Prague.

III. Sun-spot Inequalities of the period of twenty-four days, as far as this may be obtained from existing records.

The various results of the present communication are summed up as follows:—

1. The temperature-ranges at Kew, Utrecht, and Toronto exhibit certain common periods (around twenty-four days).
2. Of the curves embodying those periods that of Kew is most like the mean, and that of Toronto least so.
3. Similar phases occur at Toronto eight days before they occur at Kew, and occur at Kew one day before they occur at Utrecht.
4. Correcting for these differences of phase, the individual inequalities of Kew, Utrecht, and Toronto are very like the mean of the three, and like each other.
5. Of these the Kew inequalities are most like the mean, and the Toronto least so.
6. The declination-ranges at Kew and Prague exhibit certain common periods which we may regard as the same, or very nearly the same, as the meteorological periods above indicated.
7. Similar magnetic phases occur at Kew about one day before they occur at Prague.
8. Correcting for this difference of phase, the individual inequalities at Kew and Prague are very like the mean of the two, and like each other.
9. There is also a less striking likeness between the various magnetical and the corresponding meteorological inequalities.
10. Provisional sun-spot records appear to show certain solar inequalities very like the magnetic and meteorological inequalites in point of period.

In conclusion, the authors express the hope that steps will be taken to ascertain what information exists in the world available for these researches, and also to bring such information together for the purpose of a further and more complete discussion of the laws now indicated.

"On the Action of Nuclei in producing the Sudden Solidification of Supersaturated Solutions of Glauber's Salt," by Charles Tomlinson, F.R.S. The author states the general conclusions at which he has arrived since resuming the study of this subject two years ago. In his former papers a nucleus is defined as a body that has a stronger adhesion for the salt, or for the liquid of a solution, than subsists between the salt and the liquid. The action of nuclei the author believes to be simply mechanical, and to be expressed by the familiar word adhesion.

"On the Normal Paraffins," Part III., by C. Schorlemmer, F.R.S. Mr. Schorlemmer is inclined to believe that petroleum consists chiefly of an inextricable mixture of isomeric and homo-

logous paraffins, in which, however, the normal hydrocarbons preponderate.

"On the Solubility of Solids in Gases," by J. B. Hannay, F.R.S.E., F.C.S., and James Hogarth. The authors show the phenomenon of a solid with no measurable gaseous pressure, dissolving in a gas, and not being affected by the passage of its menstruum through the critical point to the liquid state, showing it to be a true case of gaseous solution of a solid.

"The Geometric Mean, in Vital and Social Statistics," by Francis Galton, F.R.S. Mr. Galton's purpose is to show that an assumption which lies at the basis of the well-known law of "Frequency of Error" (commonly expressed by the formula $y=e^{-h^2x^2}$), is incorrect in many groups of vital and social phenomena, although that law has been applied to them by statisticians with partial success and corresponding convenience. Next he points out the correct hypothesis upon which a Law of Error suitable to these cases ought to be calculated. Mr. Galton also communicated a memoir by Mr. Donald McAlister, who, at his suggestion, has mathematically investigated the subject.

Royal Geographical Society, *Nov.* 24.—The Earl of Northbrook, President, in the chair.

"The Arctic Campaign of 1879 in the Barents Sea," by Capt. A. H. Markham, R.N. The year 1879, the author said, would always be regarded as a very remarkable one in the annals of Arctic exploration, for during the last few months two important geographical problems had been successfully solved: The Swedish ship Vega, under the leadership of that persevering and energetic explorer, Nordenskjold, had completed her voyage from the Atlantic to the Pacific, by rounding the northern outskirts of the old world—a voyage which, even if it should not prove important in a commercial sense, would always rank as one of the greatest geographical feats of the present century; secondly, a small sailing schooner had reached the hitherto inaccessible shores of Franz-Josef Land. The vessel which accomplished this feat was the Dutch exploring schooner Willem Barents. Three hundred years ago the Dutch flag was a formidable rival of the English in the van of Arctic discovery, and English discoverers were delighted that Holland had again entered the lists and obtained a great success. The importance of the achievement of the Willem Barents could not be too highly rated, for the achievement tided over the only difficulty which, in the opinion of a great many Arctic authorities, presented itself with respect to the route for exploration. Early in the present year the author accepted an invitation from Sir Henry Gore Booth to accompany him on a sporting trip to Novaya Zemlya, with the understanding that they should afterwards examine the ice in the Barents Sea and other localities,

during what he considered to be the navigable season—namely, during the month of September. For the cruise he had hired the little Norwegian cutter Isbjörn, already rendered historical by her exploits under Payer and Count Wilczek. The Isbjörn was a vessel of 48 tons burden, 55 feet long, with a beam of 17 feet. She was built in 1870, and made her first voyage in the following year with Weyprecht and Payer. The crew consisted of a skipper, mate, two harpooners, and five seamen. They met the first ice on the fourth of June at a distance of 40 miles from the part of Novaya Zemlya coast called Goose Land. The Matochkin Shar was then impassable, and they therefore cruised along the west coast of Novaya Zemlya until they were stopped by the ice off Cape Nassau on July 15. They succeeded in passing through the Matochkin Shar on July 31, and found the Kara Sea full of heavy ice. Returning they met the Dutch exploring vessel Willem Barents on August 18. Here Captain Markham bore testimony to the great kindness they received from the officers and crew of that vessel. Everything they had was placed at their disposal. They then again shaped a course northward, along the Novaya Zemlya coast, and this time succeeded in passing Cape Nassau, and in reaching Cape Mauritius—the extreme north-western point of that land—on September 6. Finally they pushed northward on a meridian midway between Novaya Zemlya and Spitzbergen, and on the 12th they met the ice in latitude 78° north, and longitude 47° east. They pushed on and penetrated through loose streams of ice to 78° 24′, about 80 miles from Franz-Josef Land, and six miles further than that attained by the Dutch expedition last year. Captain Markham had the honour of first carrying the British flag to the northward of Novaya Zemlya. His conclusion was, looking at all the voyages in that direction, that a steamer would have no difficulty in reaching the south coast of Franz-Josef Land during the last week in August, or during the first two weeks in September. If a vessel were once able to establish herself in winter quarters on the west coast of Zichy Land the results would certainly be satisfactory. So long as the land continued to trend northward with a western aspect either a ship or a sledge would follow it without great difficulty, even if it went as far as the Pole. What was wanted in Arctic exploration was perseverance. He trusted that next season a vessel would proceed to Franz-Josef Land prepared to winter, and if it had to return it should be sent out again the following year, and from that starting point attack the work of exploration. With regard to the results of the 1879 expedition, although geographical knowledge had not been greatly increased, yet the observations that had been made with regard to physical geography would prove of the utmost value in future explorations. The Franz-Josef Land route, in his opinion, was the one that would lead to the greatest discoveries in future. The specimens of rocks and

fossils brought home were sent to Mr. Etheridge for examination, the birds and eggs to Mr. Fielden, while the plants were sent to Dr. Hooker and Mr. Oliver. A discussion followed in which Count Bylandt, Sir Leopold M'Clintock, Sir George Nares, and Admiral Hamilton took part.

PARIS.

ACADEMY OF SCIENCES, *November* 3.—The memoirs presented at this meeting included the following:—

"Result of the Researches made for the purpose of Discovering the Origin of Re-invasions of *Phylloxera*."—M. Faucon.—The author contends for the superiority of immersion to insecticides. The method he indicates is as follows:—On heavy lands, which hold water well, the immersion should be continued for 55 consecutive days; on moderately light soil, for 65 days; and on very light land, for 75 days. If the immersion is intended to destroy the eggs of *Phylloxera*, it must be carried on without the least interruption for 90 days on medium, and for 120 days on light, lands.

"A New Stellar Spectroscope."—M. L. Thollon.—M. Thollon has arrived at the conclusion that, in order not to repeat indefinitely experiments already made, three things are necessary, viz.:—(1.) That the place of observation should be as high as possible, and in a very favourable climate. (2.) That the greatest possible quantity of light should be concentrated on the slit of the spectroscope by means of an object-glass or a mirror with a broad surface. (3.) That a spectroscope should be used in which the loss of light is reduced as much as possible. It is to the solution of the latter problem that M. Thollon has specially directed his attention. He calculates the loss of light in an ordinary spectroscope to at least 57 per cent. The instrument he has invented contains two compound direct-vision prisms of special form, one in the collimator, the other in the telescope tube. The larger of the simple (or component) prisms has an angle of 100°, and contains a mixture of sulphide of carbon and ether. Two rectangular prisms of crown glass, one on either side, have faces parallel to each other and to the bisecting line of the angle of 100°. With this spectroscope M. Thollon has succeeded in economising light, and, to a certain degree, in making up for the loss that cannot be avoided.

NOTES

Biology.

The effects of the bite of the skunk are exciting some discussion. In a Monograph of the North-American Mustelidæ, by Dr. Elliot Coues (see "Quarterly Journal of Science," viii., p. 138), we read that a wound from the teeth of this animal, when in its normal state of health, rarely fails to bring on hydrophobia. The "Forest and Stream" and the "Medical and Surgical Reporter" have more recently taken up the subject. Among the authorities they quote is Dr. Cushing, of Trinidad, Colorado, who gives it as his opinion that the natural bite of the skunk, when not suffering from rabies, never fails to bring on hydrophobia. Dr. W. L. South, who has had great experience in Texas and New Mexico, asserts that the bite sooner or later results in death. It is curious, however, that no similar cases have been recorded in Pennsylvania, where the skunk is very common.

The "Journal de Pharmacie et de Chimie" for October, 1879, contains a paper on the "Actions of Life without Air; their Influence on the Chemical Phenomena of Respiration," by M. Pasteur. The author is led to believe that in the animal economy there take place phenomena of the same order as in fermentation. Oxygen acts not only by effecting combustions, but gives to the cellules an activity whence they derive the power of action beyond the influence of free oxygen, in the manner of the ferment-cells. Direct combustions are of little importance.

At a Congress of Naturalists and Physicians, on the 23rd of September, Prof. Jäger, of Stuttgart, gave a demonstration on his method of examining odours (neural analysis) and on the odours themselves. The professor also spoke on the influence of the temper. Amidst boisterous merriment he appealed to all mothers present if children, when in a good humour, did not give off a pleasant odour, but a disagreeable one when cross or fretful. The lecturer ended amidst hisses.

MM. J. Macé and W. Nicati, in their researches on colour-blindness (described to the Academy of Sciences on Oct. 27th), have sought to obtain comparative measurements between the quantities of light perceived in the different parts of the spectrum by the colour-blind on the one hand, and by the normal eye on the other. A red glass which scarcely lessens the vision of the normal eye diminishes remarkably that of a red colour-blind eye.

Microscopy.

Dr. Pelletan, in the "Journal de Micrographie," 3me année (No. 3, p. 139), complains of the little scientific value of the majority of microscopic objects prepared for sale. Preparations of diatoms are the most satisfactory as they are the easiest to make, and J. D. Möller's "Typenplatte" is especially commended by Dr. Pelletan; certain vegetable preparations, sections of dense substances, animal, vegetable, and mineral, are noticed as being very instructive. But the histological preparations, whether of man or other vertebrates, or of the invertebrates, are stated to be precisely those of least value. The usual insect preparations meet with but little favour from the writer; they present, he says, a magnificent appearance, but the integument is all that has been preserved, and the little that remains of the internal organs is represented by a uniform transparent mass, in which the microscopist finds nothing to study. Some of the English preparations mounted without pressure are very successful, particularly those of spiders, some of which show the internal organs very fairly. Complaint is made that the preparers of animal anatomical subjects have not sufficient knowledge to understand what it is necessary to make visible, and what is the characteristic detail to be rendered evident, in order to make the preparation instructive. They imagine it to be sufficient to take a piece of tissue, injected, or otherwise, harden it, make longitudinal and transverse sections, then steep it in some dye, mount it in a beautiful cell, and by these means obtain a slide useful for something. For example, in certain "commercial" histological preparations the writer notices disassociated muscular fibre, a torn nerve filament, a slice of conjunctive tissue, and the nerve terminations on a muscular fibre. What is learned? The muscular fibres have not been stretched, the sarcolemma is not evident, nor the nodes, nor the least detail of the striæ, discs, and transparent spaces; as to the other portions all is confusion, and nothing clearly displayed. The complaint is certainly true, but, it is to be feared, little will be done, as well made animal preparations are costly, and the purchasers few. Pretty objects are those which pay best.

Dr. John Matthews, F.R.M.S., Vice-President of the Quekett Club, has contrived a machine for making sections of such substances as bone, hard wood, ivory, nut, and other materials which are too hard to be cut with the section knife, and not of a nature to require the lapidary's wheel. The carriage holding the saw runs smoothly yet firmly between friction rollers, and derives its reciprocating motion from a crank, which can be turned either by hand, or when a higher speed is required, driven by a treadle and pulley. The saw is provided with

adjustments to secure its parallelism and proper tension; the thickness of the section is regulated by a screw of fifty threads to the inch, reading to thousandths by means of a micrometer head; the feed is either automatic by means of a cup, in which a suitable quantity of shot can be placed, acting by gravitation on a lever; or, as Dr. Matthews prefers, is capable of being regulated by hand. Owing to the steady motion of the saw when in proper adjustment sections of suitable tissues can be cut as thin as the thousandth of an inch; the surfaces show no trace of the saw cut, and are almost polished; very little after treatment is needed to remove the few scratches left by the saw, and if required for mounting in balsam it can be done at once, taking the usual precautions to prevent penetration, and the consequent obliteration of structure. The machine has been constructed with his usual care by Mr. J. W. Bailey.

Some interesting experiments on "Brownian Movements" have been communicated to the Royal Microscopical Society, by Wm. M. Ord, M.D. The paper, which does not admit of profitable abbreviation, will be found in vol. ii. of the Society's Transactions, p. 656.

The Royal Institution Christmas Lectures, adapted to a juvenile auditory, will this year be given by Professor Tyndall, the subject being "Water and Air." As full a report as possible will be given in the "Journal of Science."

INDEX.

ABBE, Prof., chloride of calcium in glycerin, 456
Abel, F. A., and Capt. Noble, explosives, 503
Abies excelsa, shower of sap from two trees of, 389
Abney, Capt., obtaining photographic records of absorption spectra, 447
— production of coloured spectra by light, 507
"Aborigines of Victoria" (review), 569
Abrassin oil protective against noxious insects, 765
Absorption spectra, obtaining photographic records of, 447
Academy of Sciences, Paris, 821
Achromatic microscope, compound, 175
Acids and alkalies, volumetrical determination of, 391
— methods of conveying, 709
Acoustics, studies in, 318
Adams, J. C., ellipticity of Mars and its effect on the motion of the satellites, 811
— R. D., analysis of the Australian eucalyti, 390
— W. G., new measuring polariscope, 582
Adhémar's theory of evolution, 315
Aeby, C., chemical structure of bones, 513
African coast, poisonous fishes on, 263
Agriculture, 203, 326
— science of, 355
Airy, G. B., meteorology of Bombay Presidency, 201
Albinism, vegetable, chemical study of, 812
Alcohol, destructive action of on low forms of organic life, 513
Aldehyds, action of the isobutyric anhydride on the aromatic, 200
Alkalies and acids, improvements in the volumetrical determination of, 391
Allen, A. H., "Commercial Organic Analysis" (review), 573
— G., colour and its recognition, 395
Alligator found in China, 327
Aluminium sulphate as a disinfecting agent, 709
Amber, 590
American Association for the Advancement of Science, 712
— nervousness, 598
"American Journal of Mathematics, Pure and Applied" (review), 139
American Quarterly Microscopical Journal, 776
Anæsthesia, safe, 176
"Analysis, Commercial Organic" (review), 573
"Anatomy, Studies in Comparative" (review), 314
Andre, G. G., "Spon's Encyclopædia" (review), 752
Animals, habits of in relation to the weather, 728
— senses of the lower, 316
— the band pattern in 196, 496
— the spiritual in, 333
Anomalous season, the, 650
Antarctic ice, thickness of, and its relations to that of the glacial epoch, 1
Antennæ of certain diptera, 586
Antiquities, Peruvian, 89
Anti-vivisectionist inconsistency, 700
Anti-vivisection in Germany, 452
Ants, 203, 328, 451
Ants, singular fact connected with, 328
Arago's rotation, experiments on, 447
"Archæological and Historical Association of Ireland, Journal of the Royal" (review), 119
Arctic campaign of 1879, 819
— expedition, results of the magnetical observations made by the officers of the, 445
— exploration, ballooning in, 163
Arion rufus, arrangement of veins and arteries in, 388
"Arithmetic for Use in Higher School Classes, Text-book of" (review), 114
Armstrong, Capt., standard Daniel cell, 815
Arnoux, P., new kind of honey, 389
Arsenic, detection of, 707
— determination of, 269

Arsenic in dark water-colours, 586
Arsenical wall-papers, poisoning by, 389
Articulate speech and Darwinism, 804
Arum crinitum, observations on, 702
"Ascension, Six Months in" (review), 134
Astronomical Society, 816
"Astronomy, Navigation and Nautical" (review), 644
Atlantis not a myth, 746
"Atlas, Great, Journal of Tour in Morocco and the" (review), 187
Attwood, G. A., gold nugget from South America, 378
Audiometer, 499
Aurin, 200
Aurunga and Daltonganj coal fields, 712
Ayrton, W. E., and Perry, Profs., a new theory of terrestrial magnetism, 287
— electric lighting by incandescence, 168
— Ex-isothermal model of a cooling globe, 323
Azam, Dr., double consciousness and scission of personality, 327

BACCHI, M., treatment] of bacterihæmic disease, 762
Bacillus subtilis, germs or spores of the, 513
"Bacon's Novum Organum" (review), 109
Bacterihæmic disease, treatment of, 762
Baird, S. F., "Record of Science and Industry for 1878" (review), 649
Balance, induction, 509
Ball, J., and J. D. Hooker, "Journal of a Tour in Morocco and the Great Atlas" (review), 187
— R. S., "Mechanics" (review), 646
Ballooning in Arctic exploration, 163
Bancel, M., and M. Husson, phosphorescence of the flesh of the lobster, 454
Band pattern in animals, 196, 496
Barber, S., habits of animals in relation to the weather, 728
Barometric pressure, diurnal variations of in the British Isles, 383
Barrett, W. F., attempts to overcome the induction clamour on telephones, 450
Bateman, F., Darwinism and articulate speech, 804
Bates, H. W., geographical distribution of insects, 326
Batteries, novel pump for lifting solutions out of, 511
Battery, chloride of silver, electric discharge of, 816
— for the electric light, new, 776
— improvement in Bunsen's, 394
Baynes, R. E., "Lessons in Thermodynamics" (review), 112
Bazalgette, J., electric light on the Thames Embankment, 455
Beard, G. M., American nervousness, 598
"jumpers" or "jumping Frenchmen," 247
Becquerel, H., temporary magnetic proportions developed by induction in certain specimens of nickel and cobalt, 265
Beer, mannite in, 330
Bees, parthenogenesis among, 262
Belt, Thomas, obituary, 143
Benzoic acid, artificial, from naphthalin, 330
Benzol, 454
Bergeret, M., and M. Moreau, remedy for the Peronospora infesting the lettuce, 388
Bert, M., temperature of the brain, 327
"Bible, Music of the" (review), 757
Bichromate of potash battery, constant, 202
— — — for preserving delicate marine organisms, 328
Billing, S., scientific materialism and ultimate conceptions, 661
Biological department of the survey of the territories, 453
— notes, 233, 262, 326, 388, 451, 512, 585, 701, 761, 822
"Biological Leisure Time Studies" (review), 131
Birds, insects, &c., effect of the weather on, 453
— nesting, 479
— protected from feather hunters, 262
— transformation of the beak of certain, 963
"Birds of the Colorado Valley" (review), 369
Black silks, weighting, 708, 767
Blandford, W. T., and H. B. Medlicott, "Manual of the Geology of India" (review), 698
Blonde race of mankind, origin of the, 454
Boiteau, M., action of sulphide of carbon upon the vine, 512
Bolton, H. C., legends of sepulchral and perpetual lamps, 715
Bombay Presidency, meteorology of, 201

Bones, chemical structure of, 513
Bonnier, G., anatomical and physiological study of the nectaries of plants, 451
Bordier, Dr., examination of murderers' skulls, 585
"Botany" (review), 192
"Botany, outlines of Morphology and Physiology" (review), 122
Bottomley, J. T., thermal conductivity of water, 376
Boudet, M., electrical inscription of words, 455
Bourbouze, M., improved Siren, 456
Box, live, 267
Boys, C. V., and Prof. Guthrie, experiments on Arago's rotation, 447
"Brain and Mind, Relations of" (review), 566
Brain, non-excitability of the grey cortical substance of the, 388
— temperature of the, 327
Brains of idiots, structure of the, 328
Brandt, M. E., nervous system of insects, 703
Brazilian serpent, poison of the, 764
Brearey, F. W., artificial flight, 473
Brévans, M., flight of swallows, 704
British Association for the Advancement of Science, 627, 682
— Museum, Zoological Department of, 452
Broca, Dr., brain of a Gorilla Savagii, 454
— observations made with a young barbary ape, 763
Brown, F. D., apparatus for maintaining constant temperatures and pressures, 323
Brown-Séquard, M., hereditary transmission of artificial injuries, 512
Brute and man, alleged distinction between, 145
Bug, harvest, cure for, 586
"Building Construction, Notes on" (review), 367
Bunsen's battery, improvement in, 394
Burat, Prof., mine explosions, 590
Burghardt, C. A., precious garnet from Lancashire, 770
Butler, S., "Evolution, Old and New" (review), 487
Butterflies, flight of, 586

CALDERWOOD, H., "Relations of Mind and Brain" (review), 566
Camera lucida, 265
"Canada, Geological Survey of" (review), 140, 712
Canaries, change of colour in by food, 512
Candle, Jablochkoff, its practical results in London, 290
Cannon, measurement of powder pressures in, 359
Carbon, new methods for the estimation of minute quantities of, 200
Carbons in the electric lamps, 528
Carpenter, P. H., report on the comatulæ of the *Challenger* Expedition, 320
Caterpillars, cows and ducks poisoned by, 765
Cattle food, 326
Celestials, opium smoking among the, 346
Cephalic ganglia of insects, 762
Cephalopa, liver of the, 389
Cevennes, destruction of the chesnut trees of, 203
"*Challenger*, Notes by a Naturalist on the" (review), 311
Chamberland, C., germs or spores of Bacillus subtilis, 513
Chambers, F., diurnal variations of barometric pressure in the British Isles, 383
Chance, J. T., dioptric apparatus in lighthouses for the electric light, 381
Charing Cross, fossil remains at, 453
Chatin, M., special nutritive apparatus of phanerogamic parasites, 388
Chaveau, M. A., experiments on sheep, 701
Chemical elements, are they simple bodies? 800
— industry, new, 385
— Society, 200, 321, 378, 812
— — Edinburgh University, 322
Chemistry and technology. 204 267, 328, 389, 515, 586, 705, 766
"Chemistry, A Dictionary of" (review), 251
"Chemistry, A Treatise on" (review), 193
"Chemistry of Common Life" (review), 373
"Chemistry, Organic, Manual of" (review). 489
"Chestnut-disease," 263
Chestnut trees of Cevennes, destruction of, 203
Chicken, embryo, 203
China, new kind of tortoise found in, 389
— true alligator found in, 327
Chinese diamonds, collecting, 590

Ching-men-Chow, attempt to work the coal-mines of, 772
Chlorophyll, function of, 263
Chromospheric substance of Young, note on the unknown, 377
Church, A. H., chemical study of vegetable albumen, 812
— J. A., heat of the Comstock Mines, 218, 796
"Cincinnati Society of Natural History" (review), 492
Civil Engineers, Institution of, 378, 813
"Clair's Synoptica Hymenomycetum Europæorum" (review), 130
Clamond, M., new battery for the electric light, 774
Clements, H., "Manual of Organic Chemistry" (review), 489
Clock dials, self-luminous, 267
Close, M. H., the sea-serpent, 375
"Coal" (review), 190
Coal, formation of, 677
— mines of Ching-men-Chow, attempt to work, 772
— production of, 771
Cobalt, galvanic deposits of, 708
Coccus, species known as new, 453
Cochineal insect living in the elm, 452
Cockroach, enlarged model of the brain of a, 392
Coffin, Dr., Trouvé polyscope, 450
Cohn, F., "Rose of Jericho," 203
Colloids, fracture of, 447
Collot, L., the true Phylloxera vastatrix, 454
"Colorado Valley, Birds of the" (review), 369
Colour and its recognition, 395
"Colour-blindness" (review), 756
Colour-blindness, use of coloured glasses in cases of, 513
Colour-sense, evolution of, 512
Colouring-matter, preparation of, 707
Colours, alleged poisonous, concerning the use of, 391
— classification of, 268
Comatulæ of the *Challenger* Expedition, Report on the, 320
Comstock Mines, heat of the, 218, 796
Conroy, J., distribution of heat in the spectrum, 582
— experiments on metallic reflexion, 198
Cooke, M. C., and L. Quelet, "Clair's Synoptica Hymenomycetum Europæorum" (review), 130
Cornu, M., Crassulaceæ of cortical woody bodies agglomerated together, 388
— new malady attacking plants, 451
Costes, V. D., ants, 203
Cotton-dyeing, tartar emetic in, 515
Coues, E., "Birds of the Colorado Valley" (review), 369
Coursserrant, M., use of coloured glasses in cases of colour-blindness, 513
Couty, M., non-excitability of the grey cortical substance of the brain, 388
— physiological action of maté, 262
— and M. De Lacerda, poison of Brazilian serpent, 764
Cows and ducks poisoned by caterpillars, 765
Crassulaceæ of cortical woody bodies agglomerated together, 388
Crayfish, contraction of the muscles of the, 453
— effect of heat on the functions of nerve-centres of the, 512
Creak, E. W., results of the magnetical observations made by the Officers of the Arctic Expedition, 445
Creosote as a preservative of timber against the Teredo, 330
Criminal laws of the future, 591
Croll, J., thickness of the Antarctic ice, and its relations to that of the Glacial epoch, 1
Crookes, W., electrical insulation in high vacua, 240
— gravitation as a factor in the organic world, 34
— molecular physics in high vacua, 411
Crops and soil by waste waters, damage to, 768
Crossley, E., "A Handbook of Double Stars" (review), 810
— new form of microphone, 816
Crystal growing, large, 328
Currents, electric, measuring and regulating, 255
Cyclones, inclination of the axes of, 385

DAHLL, T., Norwegium, 589
Dale, R. S., and C. Schorlemmer, on aurin, 200
Daltonganj and Aurunga coal-fields, 712
Dareste, M., certain granules in the yolk of an egg, 388
— embryo chicken, 203
— experiments on eggs, 704
Darwinism and articulate speech, 804

Daubréelite, new meteoric mineral, 270
Davis, J. W., fish remains in cannel coal, 813
Death, the keys of, 209
— painless, 306
De Bellesme, J., liver of the Cephalopa, 389
De Boisbaudran, L., examination of the mixture of earths from samarskite with the spectroscope, 394
Décharme, M., flight of butterflies, 586
De la Bastie, improvements in tempering glass, 269
De Lacerda, M., and M. Couty, poison of Brazilian serpent, 764
De la Rue, Dr., conical pendulum for driving clock of equatorial, 811
— electric discharge with chloride of silver battery, 816
Delhi, visit to ancient observatory, 787
De Luynes, M., varnishes in printing inks, 768
De Mollins, J., chemical purification of wash waters, 768
De Mortillet, G., early traces of man, 341
De Plessis, G., bichromate of potash for preserving delicate marine organisms, 328
De Seynes, "chestnut disease," 263
Dew, mist, and fog, 384
— new theory of, 471
Diamonds, Chinese, 590
"Dictionary of Scientific Terms, Illustrated" (review), 189
Dines, G., dew, mist, and fog, 384
Dioptric apparatus in lighthouses for the electric light, 381
Diptera, certain, antennæ of, 586
— nervous system of the, 703
Dipterous insect, larva of a, 513
Disinfecting, measures for, 766
Dodgson, C. L., "Euclid and his Modern Rivals" (review), 492
— W., and B. Stewart, note on the inequalities of the diurnal range of the declination magnet, as recorded at the Kew Observatory, 198
Dogs, experiments on, 388
Dolbear, Prof., new galvanometer, 392
"Double Stars, Handbook of" (review), 810
Douglass, J. N., electric light applied to lighthouse illumination, 378
Donnet, J. B., museum founded by, 701
Draper, H., oxygen in the sun, 515
Dryness versus humidity, 201
Ducks and cows poisoned by caterpillars, 765
Dupré, Dr., and H. W. Hake, two new methods for the estimation of minute quantities of carbon, 200
Dust, combustible, explosions from, 666
Dyes, two new green, 329
"Dynamics of a Particle" (review), 114
Dynamo-electric machines, magnetic circuits in, 817

EARTH, cause of the form of, 331
Edinburgh University Chemical Society, 322
Education, technical, in England, France, and Germany, 790
Edwards, W. H., curious fact connected with ants, 328
Egg, certain granules in the yolk of an, 388
Eggs, experiments on, 704
— silkworms', preservation of, 391
Electric apparatus, new catalogue of, 776
— burner, new, 455
— clock used in experiments on tuning-forks, 581
— currents, measuring and regulating, 255
— discharge of chloride of silver battery, 816
— fishes, researches on, 393
— — touch of, 512
— lamp, carbons in the, 528
— light, 207, 260, 264, 587, 644
— — applied to lighthouse illumination, 378
— — dioptric apparatus in lighthouses for the, 381
— — for India, 205, 303
— — new battery for, 776
— — regulator, E. Regnier's, report on, 332
— lighting by incandescence, 168, 450
— — contribution to the history of, 155
— — report on, 455, 518
"Electric Induction, Static" (review), 646
Electrical discharges through rarefied gases, sensitive state of, 440
— inscription of words, 455
— insulation in high vacua, 240
Electricity and light, new relation between, 318

Electricity by the ray, production of, 701
— nickelising without, 708
— transmission of power by means of, 183
"Electricity and Magnetism" (review), 114
"Electricity, Text-book of" (review), 646
Electro-magnetic regulator, improved siren with, 456
Elements, chemical, are they simple bodies? 800
Ellis, W., relation between the diurnal range of magnetic declination and horizontal force, 444
Elm, cochineal insect living on the, 452
Elphinstone, Lord, magnetic circuits in dynamo- and magneto-electric machines, 817
Embryogenous cellule detected in the ova of various animal groups, 761
Engelmann, T. W., microscopic phenomena of muscular contraction, 393
Engineers, Civil, Institution of, 378
England's intellectual position, 519
"Entomological Commission, United States, First Annual Report of the" (review), 129
Erck, Dr., constant bichromate of potash battery, 202
— novel pump for lifting solutions out of batteries, 511
Etheridge, R., and H. A. Nicholson, "Monograph of the Silurian Fossils of the Girvan District" (review), 314
"Etna, a History of the Mountain and its Eruptions" (review), 127
Eucalypti, analysis of the Australian, 390
Eucalyptus, and the Pine, 766
"Euclid, and his Modern Rivals" (review), 492
"Europæorum, Clair's Synoptica Hymenomycetum" (review), 130
Evolution, Adhémar's theory of, 315
"Evolution, Old and New" (review), 487
Exisothermal model of a cooling globe, 323
Explosives, 503
Eye, experiments on the, 454

FAUCON, the origin of remains of phylloxera, 821
Fauvel, A. A., true alligator found in China, 327
Feather hunters, birds protected from, 262
Fishes, poisonous, 263, 703
— electric, 393, 512
— respiration of, 512
Fitzgerald, G. F., electromagnetic theory of the reflection and refraction of light, 199
Flannel, Saxony, red azo-colouring matters for, 329
Fleck, H., arsenic in dark water colours, 586
Flight, artificial, 473
— the problem of, 163
"Flowers, and their Unbidden Guests" (review), 137
Fog, mist, and dew, 384
Fossil remains at Charing Cross, 453
Fournol, M. L., poisonous fishes, 703
Fowler, T., "Bacon's Novum Organum" (review), 109
Frankland, E., and A. Lawrance, on stannic ethide, 200
Frederic, L., blood of the octopus and lobster, 765
— composition of the plasma of the blood, 453
— octopus, 203
French Association for the Advancement of Science, 713
"Frenchmen, jumping," or the "jumpers," 247

GAIFFE'S galvanic deposits of cobalt, 708
Galippe, M., experiment with a rabbit, 589
Galtier, M., studies on rabies, 761
Galton, F., geometric mean in vital and social statistics, 819
Galvanic deposits of cobalt, 708
Galvanometer, new, 392
Ganglia of insects, cephalic, 762
Garnet, precious, from Lancashire, 770
Gas versus electricity, 206
Gases and acid vapours given off by chimneys of chemical works, composition and measuring the volume of, 329
Gases, sensitive state of electrical discharges through rarefied, 443
Gases, solids in, 819
Gasteropod mollusks, action of the salts of strychnin upon the, 514
Geddes, P., function of chlorophyll, 263
Geoffrey, M., evolution of colour-sense, 512
Geographical Society, 819

"Geological and Geographical Survey of the Territories," annual report (review), 441, 490
"Geological and Geographical Survey of the Territories, Bulletin of the United States" (review), 141, 191
"Geological and Geographical Survey of the Territories for 1877, Preliminary Report of the Field work" (review), 118
Geological and Polytechnic Society, Yorkshire, 331
"Geological Notes and Geology of Ireland" (review), 647
Geological Society, 812
"Geological Survey of Canada" (review), 140, 712
Geological survey of India, 120, 191, 710
— — of Victoria, 119, 270
Geology, notes, 331, 710
"Geology and Geological Notes of Ireland" (review), 647
"Geology of India, Manual of" (review), 698
Geology of the salt range in the Punjab, 711
German, Imperial, flower-blue, 707
Germany, anti-vivisection in, 452
Geyser, water and gas, 805
Gill, Mrs., "Six Months in Ascension" (review), 134
"Girvan District, Monograph of the Silurian Fossils of the" (review), 314
Gledhill, J., "A Handbook of Double Stars" (review), 810
Gittins, E., ants, 451
Glacial epoch, thickness of Antarctic ice, and its relations to that of the, 1
Glacier action in the Punjab, ancient, 338
Glasgow, Philosophical Society of 207
Glycerin, chloride of calcium in, 456
Gold nugget from South America, 378
Gordon, J. E. H., "Four Lectures on Static Electric Induction" (review), 646
— new relation between electricity and light, 318
Gore, G., "Art of Scientific Discovery" (review), 112
Gorilla Savigii, brain of a, 454
Gower's improved form of Bell's speaking telephone, 449
Graft and stock, mutual influence of, 764
Graham, Prof., triennial lecture in memory of, 207
Graphite in New Zealand, 269
Gravitation as a factor in the organic world, 34
Greaves, C., dryness versus humidity, 201
Green, Miall, Thorpe, Rucker, and Marshall, "Coal" (review), 190
Greenwood, F., and L. C. Miall, "Studies in Comparative Anatomy" (review), 314
Gros, C., classification of colours, 268
Gunning, Prof., supposed destructive action of alcohol on low forms of organic life, 513
Guthrie, F., fracture of colloids, 447
— "Practical Physics" (review), 250
— and C. F. Boys, experiments on Arago's rotation, 447
— results of experiments on the vibrations of metal rods fixed at one end, 202

HAECKEL, E., protistic kingdom of biology, 585.
Hake, H. W., and Dr. Dupré, two new methods for the estimation of minute quantities of carbon, 200
Hannay, J. B., action of chlorine upon iodine, 201
— solids in gases, 819
Harker, A., bird's-nesting, 479
Harmonograph, 508
Hartley, W. N., absorption of the ultra-violet rays of the spectrum of organic substances, 198
Harvest bug, cure for, 586
Hasenclever, R., injury to vegetation by acid gases, 705
Hayden, F. V., "Geological and Geographical Survey of the Territories," tenth annual report (review), 441
Hayter, H. H., "Victorian Year-Book for 1877-8" (review), 438
Heath, E. R., Peruvian antiquities, 89
Heart-poisons, action of certain, 763
Heat in the spectrum, 582
— influence of upon induction coils, 815
— of the Comstock mines, 218
"Heavens, Dreams of the Mysteries of the" (review), 643
Heckel, E., action of salts of strychnin upon the gasteropod mollusks, 514

Hennessey, J. B. N., transit of Venus in 1874, 806
Helm, M., amber, 590
Henrichs, R., E. Wein, J. Nessler, and A. Mayer, cattle food, 326
Héraud, M., new voltaic pile, 265
Herbert, T. M., "Realistic Assumptions of Modern Science Examined" (review), 253
Heredity, 495, 759
Hereditary transmission of artificial injuries, 512
Heron, breast of the, 513
Herzen, A., physical conditions of consciousness, 514
Higgs, P., "The Electric Light in its Practical Applications" (review), 644
Histological uses, mixture for, 762
Histologist, osmic acid and other stains for the, 705
Hollway, J., rapid oxidation, 588
Holmium and thulium, new elements, 707
Honey, new kind of, 389
Hooker, J. D., and J. Ball, "Journal of a Tour in Morocco and the Great Atlas" (review), 187
Horizontal force, relation between the diurnal range of magnetic declination and, 444
Houston, E. J., and E. A. Thomson, curious thermo-magnetic motor, 217
— — transmission of power by means of electricity, 183
Horworth, A., production and maintenance of life, 454
Hughes, Prof., induction balance, 509
— audiometer, 499
Hughes, W., "Outlines of Geology and Geological Notes of Ireland" (review), 647
Human hair, peculiarity of, 268
Humanitarianism extraordinary, 651
Humidity, dryness versus, 201
Huntilite occurs at the silver mine, Lake Superior, 589
Huntingdon, A. K., and W. N. Hartley, absorption of the ultra-violet rays of the spectrum by organic substances, 198
Husson, M., and M. Bancel, phosphorescence of the flesh of the lobster, 454
Hydrogen, peroxide of, in plants, 262
"Hydrostatics and Pneumatics" (review), 113

ICE-CAVES, paradoxical phenomena in, 525
Ice, thickness of Antarctic, and its relation to that of the Glacial epoch, 1
Illusions, some new optical, 234, 316
Incandescence, electric lighting by, 168
India, electric light for, 205, 303
"India, Geological Survey of" (review), 120, 191, 710
"India, Manual of the Geology of" (review), 698
Induction balance, 509
Induction clamour on telephone, attempts to overcome, 450
Induction coils, influence of heat upon, 815
"Industry and Science for 1878, Record of" (review), 649
Infectious and malarious diseases, causes of, 389
Ink ineradicable, 587
Insects, noxious, abrassin oil protection against, 765
— birds, &c., effect of the weather on, 453
— geographical distribution of, 326
— nervous system of, 703
Instinct or reason, 173
Intellectual position, England's, 519
"Invertebrata" (review), 122
Iron surfaces, prevention of corrosion on, 771
Iron trade, position of the French, 205
Isobutyric anhydride, action of on the aromatic aldehyds, 200

JABLOCHKOFF candle, its practical results in London, 290
Jamin, M., new electric burner, 455
Japanese lacquer, chemical investigation of, 324
Jeffries, B. J., "Colour Blindness" (review), 756
Jenkin, F. E., "Electricity and Magnetism" (review), 114
Johnen, A., comparative observations of rainfall, 326
Johnston, F. W., "Chemistry of Common Life" (review), 373
Jordan, S., position of the French iron trade, 205
Jourdain, M. S., arrangement of arteries and veins in Arion rufus, 388
"Jumpers," the, or "Jumping Frenchmen," 247

KANSAS and Missouri, tornadoes of, 613

Keates, Mr., and J. Bazalgette, report on the electric light on the Thames Embankment, 455
Kerner, A., "Flowers and their Unbidden Guests" (review), 137
Keys of death, the, 209
Kingzett, C. T., pine and eucalyptus, 766
Kjerulfine, Wagnerite identical with, 269
Kühn, Prof., experiments on the eye, 454
Künckel, M. J., nervous system of the diptera, 703

LACERDA, poison of serpents, 262
Lami, milking, 706
Lamps, legends of sepulchral and perpetual, 715
Langley, S. P., temperature of the sun, 654
Latchinoff, M., electric light, 264
Lavoisier, M., apparatus of, 587
Law, physical, thoughts on our conception of, 276
Lawrance, A., and E. Frankland, on stannic ethide, 200
Le Doux, C., action of quinine upon silkworms, 765
Lealand and Powell, Messrs., oil immersion objective, 456
Leaves and their functions, 406
Leeds, A. R., sanitary science in the United States, 49
Lefebure, M., improvements in Bunsen's battery, 394
Lemmon, J. G., age of the sequoias of California, 513
Lepidoptera from the Amur river, 452
Lettuce, remedy for the Peronospora infesting the, 388
Ley, W. C., inclination of the axes of cyclones, 385
Lichtenstein, J., cochineal insect living on the elms, 452
— metamorphoses of the Spanish fly, 764
Life, production and maintenance of, 454
— saving stations in mid ocean, plan for, 341
Light, action of on the colouration of the organic world, 650
— — on plants, 784
— and electricity, new relation between, 318
— electric, 207, 260, 264, 450, 587, 644
— — dioptic apparatus in lighthouses for the, 381
Lights, different coloured, action of upon the development of animal ova and larvæ, 204
Lighthouse illumination, electric light applied to, 378
Lighting, electric, contribution to the history of, 155
— — by incandescence, 168
— report on, 518
"Literary and Philosophical Society of Liverpool" (review), 371
Literary and Philosophical Society of Manchester, 324
Live box, 297
Liveing, G. D., note on the unknown chromospheric substance of Young, 377
— spectroscopic papers, 575
Lobster and octopus, blood of, 765
— phosphorescence of the flesh of the, 454
Lochaber, origin of the parallel roads of, 497
Lockyer, J. N., communication by Messrs. Liveing and Dewar, 505
— researches on nature of chemical elements, 800
— spectrum of sodium, 503
Longevity, 734
Lontin electric light, improvements in, 722
Lowe, R. M., paradoxical phenomena in ice-caves, 525
Lubbock, Sir J., "Scientific Lectures" (review), 565
Lucida camera, 265
Luvini, G., preservation of silkworms' eggs, 391
Lydekker, R., "Memoirs of the Geological Survey of India" (review), 120

MACALISTER, A., "Introduction to Systematic Zoology and Morphology of Vertebrate Animals" (review), 368
— "Invertebrata" (review), 122
— "Vertebrata" (review), 123
Macé, J., researches on colour-blindness, 822
Magnetical observations, results of made by the officers of the Arctic Expedition, 445
Magnetism, a new theory of terrestrial, 287
"Magnetism and Electricity" (review), 114
Magneto-electric machines, magnetic currents in, 817

Mallet, R., temperature of primordial ocean of our globe, 812
Magnus, P., "Hydrostatics and Pneumatics" (review), 113
Man and brute, alleged distinction between, 145
— antiquity of, 675
— early traces of, 401
Manchester Literary and Philosophical Society, 324
Mankind, origin of the blonde race of, 454
Mannite in beer, 330
Markham, Capt., Arctic campaign of 1879, 816
Marey, E. J., researches on electric fishes, 393
Marriott, W., thermometer exposure, 507
Mars, ellipticity of, 811
Marsh, S., "Section Cutting" (review), 135
Marshall, Green, Thorpe, Miall, and Rucker, "Coal" (review), 190
Match struck upon the nail, death from, 262
Matê, physiological action of, 262
Materialism, scientific, and ultimate conceptions, 661
"Mathematics, Pure and Applied, American Journal of" (review), 139
Matter active, 226
Matter dead, 150
Matthews, J., machine for making sections, 823
Mattison, R. V., opium smoking among the Celestials, 346
Mayer, A., R. Heinrichs, E. Wein, and J. Nessler, cattle foods, 326
— J. R., memorial to, 267
— P., antennæ of certain diptera, 586
McCoy, F., "Natural History of Victoria" (review), 439
McLeod, H., electric clock used in experiments on tuning-forks, 581
— rate of vibration of tuning-forks, 257
McNab, W. R., "Botany" (review), 122
"Mechanics" (review), 646
Medlicott, H. B., and W. T. Blandford, "Manual of the Geology of India" (review), 698
Mensel, M., preparation of colouring matter, 707
Mental inanition, 375
Merget, M., use of mercurial vapours for studying the structure of vegetable matter, 389
Metallic reflexion, experiments on, 198
Metallurgy, 205, 269, 331, 588, 770
Metal, new, made from iron and steel, 332
Metals, remarkable welding of two, 332
Meteoric mineral, new, 270
Meteorological Society, 201, 383, 507
Miall, L. C., and F. Greenwood, "Studies in Comparative Anatomy" (review), 314
— Thorpe, Rucker, Marshall, and Green, "Coal" (review), 190
Micrometers, spiders web for, 245, 315
Micrometry, standard unit of, 456
Microphone, new form of, 816
Microscope, compound achromatic, 175
— simple contrivance for holding the object beneath the stage of the, 392
"Microscope, Selection and Use of the" (review), 373
Microscopic objects, little scientific value of, 823
phenomena of muscular contraction, 393
Microscopical researches, definition in high power, 576
— Society, alteration in the, 393
— — Journal of, 392
Mid-ocean, plan for life-saving stations in, 341
Milking, 706
"Mind and Brain" (review), 566
Mine explosions, 590
Mines, accidents resulting from heat of, 796
— Comstock, heat of the, 218
Mineral wealth of Turkey, 590
"Mining Surveyors and Registrars of Victoria, Reports of the" (review), 136
Missouri and Kansas, tornadoes of, 613
Mist, fog, and dew, 384
Molecular physics in high vacua, 411
Moulton, S. F., and W. Spottiswoode, sensitive state of electrical discharges through rarefied gases, 443
Monkeys, an honest cashier, 345
"Moon, Researches on the Motion of the" (review), 642
"Moon, the, her Motions, Aspect, Scenery, &c." (review), 111
Mordant from lees of wine, 708
Morea, A., experiments on dogs, 388

"Morocco and the Great Atlas, Journal of a Tour" (review), 187
Mosely, H. N., "Notes by a Naturalist on the *Challenger*" (review), 311
Moving rocks, 610
Moyret, M., weighting black silks, 708, 767
Mudge, B. F., antiquity of man, 675
Muir, T., "Text-book of Arithmetic for Use in Higher School Classes" (review), 114
Muller, H. W., electric discharge with chloride of silver battery, 816
Murphy, J. J., Is organic variation fortuitous? 350
Muscular contraction, microscopic phenomena of, 393
Mushrooms, poisoning by, 269
"Music of the Bible" (review), 757
Mussett, C., shower of sap from two trees of Abies excelsa, 389

NAEGELI, M., cause of infectious and malarious diseases, 389
Naphthalin, artificial, benzoic acid from, 330
National scientific appointments, 723
"Natural History of Victoria" (review), 439
"Naturalist, the Scottish" (review), 141
Nature, course of, 64
— imperfections of, 442
Nature, is it perfect? 271
Naudin, M., and M. Radlkofer, change of climate on plants, 763
"Navigation and Nautical Astronomy" (review), 644
Nectaries of plants, anatomical and physiological study of the, 451
Nervous phenomena, propagation of, 454
Nessler, J., A. Mayer, R. Heinrichs, and E. Wein, cattle foods, 326
Nervins, W., heredity, 759
Newcomb, S., "Researches on the Motion of the Moon" (review), 642
— the course of Nature, 64
"New South Wales, Proceedings of the Royal Society of" (review), 439
Newton, E. J., construction of an enlarged model of the train of a cockroach, 392
New Zealand, graphite in, 269
Nicati, W., researches on colour-blindness, 822
Nicholson, H. A., and R. Etheridge, "Monograph of the Silurian Fossils of the Girvan District" (review), 314
Nickel and cobalt, temporary proportions developed by induction in certain specimens of, 265
Nickelising without electricity, 708
Nipher, F. E., thoughts on our conceptions of physical law, 276
Nitrobenzol, guinea-pigs affected by vapour of, 702
Noad, H. M., "Text-Book of Electricity" (review), 646
Noble, Capt., and F. A. Abel, explosives, 503
Norwegium, 589
"Novum Organum, Bacon's" (review), 109
Noyes, J. P., plan for life-saving stations in mid-ocean, 341

OBITUARY, 143
Observatory at Delhi, visit to, 787
Octopus, 203
— and lobster, blood of the, 765
Oil immersion objective, 456
Olive oil adulteration, 767
Opium smoking among the Celestials, 346
Optical illusions, some new, 234, 316
"Organic Analysis, Commercial" (review), 573
"Organic Chemistry, Manual of" (review), 489
Organic life, supposed destructive action on low forms of, 513
— substances, absorption of the ultra-violet rays of the spectrum by, 198
— variation, is it fortuitous? 350
— world, action of light on the colouration of the, 650
— — gravitation as a factor in the, 34
"Ornamental and Textile Fabrics, Report of the New Jersey State Commissioner appointed to Devise a Plan for the Encouragement of Manufacturers of" (review), 115
Osmic acid and other stains for the histologist, 705
— — for microscopical purposes, 704
Ova and larvæ, action of different coloured light upon the development of animal, 204
— of various animal groups, embryogenous cellule detected in the, 761

Ovaries in female mammals after birth, development of, 388
Oxidation, rapid, 588
Oxygen in the sun, 515
Ozone, action of on the colouring-matters of plants, 706

PAIN and the weather, 527
Palmella cruenta, the, 706
Palmer, J. A., poisoning by mushrooms, 269
Paradoxical phenomena in ice caves, 535
Parasites, special nutritive apparatus of phanerogamic, 388
Paraffin and what is got from it, 322
Parker, J. D., tornadoes of Kansas and Missouri, 613
Parthenogenesis among bees, 262
"Particle, Dynamics of a" (review), 114
Pascoe, F. P,, new species of Sidero-dactylus, 203
Pasteur, M., actions of life without air, 822
Paterson, E., new catalogue of electric apparatus, 776
"Pathology of the Urine, including a Complete Guide to its Analysis" (review), 124
Patry, M. M., "Puteaux blue," 767
Peck, L. W., explosions from combustible dust, 666
Pellatin, Dr., microscopic objects, 823
Perkin, W. H., action of isobutyric anhydride on the aromatic aldehyds, 200
Peronospora infesting the lettuce, remedy for the, 388
Peroxide of hydrogen in plants, 262
Perry and Ayrton, Profs., a new theory of terrestrial magnetism, 287
Peruvian antiquities, 89
Petroleum as a steam maker, 612
— oils, improved device for testing, 709
"Petrology, Elementary Text-book of" (review), 252
Pharmaceutical antiquities, 768
Philosophical Society of Glasgow, 207
"Philosophical Society of Queensland, Report of the" (review), 118
Phin, J., "Selection and Use of the Microscope" (review), 373
Phosphates, two new, 589
Photographic records of absorption spectra, 447
Phylloxera, commission of the French Academy, 203
— vastatrix, the true, 454
Physical conditions of consciousness, 514
— law, thoughts on our conception of, 276
— Society, 202, 260, 322, 447, 508, 579, 814
Physics, notes on, 205, 264, 332, 392, 455, 515, 772
— molecular, in high vacua, 411
"Physics, Practical" (review), 250
Pine and the eucalyptus, 766
Pineapple, smoke of burning straw beneficial to, 702
Pirate's sheet anchor, 622
Pisani, F., wagnerite identical with kjerulfine, 269
Plants, action of light on, 784
— change of climate on, 763
— new malady attacking, 451
— ozone on the colouring-matters of, 706
"Plastering" wines, 204
Plasma of the blood, composition of the, 453
"Pneumatics and Hydrostatics" (review), 113
Poincaré, M., effects of inhaling oil of turpentine, 515
— guinea pigs affected by vapour of nitrobenzol, 702
Poison of serpents, 262
Poisonous colours, concerning the use of alleged, 391
Polariscope, new measuring, 582
Pollacci, E., "plastering" wines, 204
Polyscope, Trouvé, 450
Ponton, M., "The Freedom of the Truth" (review), 130
Potable waters, organic purity of, 321
Pouchet, G., touch of electrical fishes, 512
Powder pressures in cannon, measurement of, 359
Powell and Lealand, Messrs., oil immersion objective, 456
"Practical Physics" (review), 250
Preece, W. H., and A. Stroh, studies in acoustics, 318
— gas versus electricity, 206
Prestwich, J., origin of the parallel roads of Lochaber, 497
Prisms, complex arrangement of, 265
Printing inks, varnishes in, 768
Proctor, R. A., "The Moon, her Motions, Aspect, Scenery, &c." (review), 111
Protistic kingdom in biology, 585

Prusol, J., "Dreams of the Mysteries of the Heavens" (review), 643
Punjab, ancient, glacier, action in the, 338
— geology of the salt range in the, 711
"Puteaux blue," 767

QUEEN BEE, "stingless," 262
"Queensland Philosophical Society, Report of the" (review), 118
Quelet, L., and M. C. Cooke, "Clavis Synoptica Hymenomycetum Europæorum" (review), 130
Quick, J., the old stannaries of the West of England, 282
Quin, C. W., large crystal growing, 328
— the Jablochkoff candle; its practical results in London, 290

RABIES, studies on, 761
Radlkofer, M., and M. Naudin, change of climate on plants, 763
Rainfall, comparative observations of, 326
Rambosson, J., propagation of nervous phenomena, 454
Rath, J., two new phosphates, 589
Raw silk, preparation of, 709
Read, W. T., "Navigation and Nautical Astronomy" (review), 644
Reason or instinct? 173
Reflection and refraction of light, electro-magnetic theory of, 199
Regnier, E., report on his electric light regulator, 332
Renon, B. E., weather predictions, 701
Renaut, J., mixture for histological uses, 762
Research, endowment of, 760
"Rhymes of Science" (review), 367
Richardson, B. W., researches on Prof. Hughes's audiometer, 499
— sphygnophone, 502
Richet, C., contraction of the muscles of the crayfish, 453
— effects of heat on the functions of the nerve-centre of the crayfish, 512
Roberts, E., new tide-predictor, 577
— W. C., analogy between conductivity for heat and induction balance effect of copper-tin alloys, 814
Robin, C., production of electricity by the rays, 701
Rocks, moving, 601
Rodwell, G. F., "Etna; a History of the Mountain and its Eruptions" (review), 127
— history of Vesuvius during the last ten years, 463
Roscoe, H. E., new chemical industry, 385
— "Treatise on Chemistry" (review), 193
"Rose of Jericho," 203
Rossiter, W., "Illustrated Dictionary of Scientific Terms" (review), 189
Royal Institution of Great Britain, 385
— Society, 198, 255, 318, 376, 443, 497, 575, 816
— — Soirée scientific novelties, 516
"Royal Society of New South Wales, Proceedings of the" (review), 439
"Royal Society of Tasmania, Papers, &c., of" (review), 754
"Royal Society of Victoria, Transactions and Proceedings of" (review), 437
Royston-Pigott, G. W., microscopical researches in high-power definition, 576
Rucker, Marshall, Green, Miall, and Thorpe, "Coal" (review), 190
Russell, Dr., instrument for microscope, 266
Rutley, F. E., "Elementary Textbook of Petrology" (review), 252

SAFFRON, adulteration of, 205
Salt-range in the Punjab, geology of the, 711
Samarskite, examination with the spectroscope of mixture of earths from, 394
Sanitary science in the United States, 49
Sea-serpent, the, 196, 315, 375, 759
Season, the anomalous, 457, 650
Seasons, extraordinary, 574
Seed-breeding, 531
Selmi, Prof., detection of arsenic 737
Senses, the, 495
— of the lower animals, 316
Sepulchral and perpetual lamps, legends of, 715
Sequoias of California, age of the, 513
Serpents, habits of, 651
— poison of, 262
Sexes, character of the, 254

Schnetzler, B., observations on Arum crinitum, 702
Schorlemmer, C., normal paraffins, 818
— and R. S. Dale, on aurin, 200
Schuchardt, T., silicium strontium. 205
Schuster, Dr., spectroscope with two prisms, 322
Schwendler, L., suitability of the electric light for India, 205
"Science, Fragments of" (review), 642
"Science made Easy" (review), 190
"Science of Industry for 1878, Record of" (review), 649
"Science, Modern, The Realistic Assumptions of" (review), 253
"Science, Rhymes of" (review), 367
Science, sanitary, in the United States, 49
Scientific appointments, national, 723
— materialism and ultimate conceptions, 661
— novelties at the Royal Society Soirée, 516
"Scientific Discovery, Art of" (review), 112
"Scientific Lectures" (review), 565
"Scientific Terms, Illustrated Dictionary of" (review), 189
"Scottish Naturalist" (review), 141
Sharks' mouths, peculiar position of, 452
Sheep experiments on, 701
Shettle, Dr., influence of heat upon induction coils, 815
Sheet anchor, pirates', 622
Shoolbred, J., electric lighting, 260
Siderodactylus, new species, 203
Siemens, C. W., measuring and regulating electric currents, 255
Siemens's electric light, 773
Silicium strontium, 205
Silk, preparation of raw, 709
Silkworms, action of quinine upon, 765
"Silurian Fossils of the Girvan District, Monograph of the" (review), 314
Simon, C., "Solar Illumination of the Solar System" (review), 643
Siren, improved, with electro-magnetic regulator, 456
Skulls, examination of, 585
Skunk, bite of, 822
Slater, J. W., anti-vivisectionist inconsistency, 700
Slouginoff, M., experiments with two electrodes of a battery, 264
Smith, A. P., poisoning by wall papers, 389
Smith, J. L., new meteoric mineral, Daubréelite, 270
"Smithsonian Institution, Annual Report of the Board of Regents" (review), 192
Smyth, R. B., "The Aborigines of Victoria" (review), 569
"Section Cutting" (review), 135
Sodium, spectrum of, 503
Soil and crops by waste waters, drainage to, 768
Solar radiation, and the temperature indicated by the Black-bulk thermometer *in vacuo*, relation between duration of sunshine, and the amount of, 384
"Solar Illumination of the Solar System" (review), 643
Sound as a nuisance, 442
"Sound, Elementary Lessons on" (review), 754
"Sound, Theory of" (review), 110
Spanish fly, metamorphoses of, 764
Species, transformation of, 254
Spectra by light, production of coloured, 507
Spectroscope, examination of the mixture of earths from Samarskite with the, 394
— with two prisms, 322
— new stellar, 821
Spectroscopic papers, 575
Spectrum, distribution of heat in the, 582
Sphygmophone, 502
Spiders' web for micrometers, 245,315
Spiritual in animals, 333
Spon's "Encyclopædia of the Industrial Arts, &c." (review), 752
Spottiswoode, W., testimonial to, 332
— and F. S. Moulton, sensitive state of electrical discharges through rarefied gases, 443
Stainer, J., "Music of the Bible" (review, 757
Stannaries, old, of the West of England, 282
Stannic ethide, 200
"Stars, Double, a Handbook of" (review), 810
"Static Electric Induction" (review), 646
Steam maker, petroleum as a, 612
Steels, chemical composition and mechanical properties, 331
Stewart, B., comparisons of the variations of the diurnal range of magnetic declination, 256
— existence of short periods common to solar and terrestrial phenomena, 817

Stewart, B., and W. Dodgson, the inequalities of the diurnal range of the declination magnet as recorded at the Kew Observatory, 198
Stock and graft, mutual influence of, 764
Stone, W. H., "Lessons on Sound" (review), 754
Sturtevant, E. L., seed breeding, 531
Stroh, A., and W. H. Preece, studies in acoustics, 318
— telephone, 206
Strontium silicium, 205
Strutt, J. W., "Theory of Sound" (review), 110
Strychnin, salts of, action of upon the Gasteropod mollusks, 514
Substances, new elementary, 706
Sulphate, aluminium, as a disinfecting agent, 709
Sun, oxygen in the, 515
— temperature of the, 654, 732
Swallows, flight of, 704
Sylvester, J. J., "American Journal of Mathematics, Pure and Applied" (review), 139

TAIT, P. G., "Treatise on the Dynamics of a Particle" (review), 114
Tartar emetic in cotton dyeing, 515
Technical education in England, France, and Germany, 790
Technology and chemistry, 204, 267, 328, 389, 515, 586, 705, 766
"Telegraph Engineers, Journal of the Society of" (review), 572
Telephone, 206
— Bell's speaking, improved form of 449
Telephones, attempts to overcome induction clamour on, 450
Telescopes for viewing objects at short distances, value of, 208
Temperatures and pressures, constant, apparatus for maintaining, 323
Tempering glass, improvements in, 769
Templin, L. J., leaves and their functions, 406
Teredo, creosote as a preservative of timber against the, 330
Terrestrial magnetism, a new theory of, 287
Thames Embankment, report on the electric light on the, 455
"Theory of Sound" (review), 110
Thermal conductivity of water, 376
"Thermo-dynamics, Lessons in" (review), 112
Thermo-magnetic motor, a curious, 217
Thermometer exposure, 507
— black bulb in vacuo, relation between duration of sunshine, amount of solar radiation, and the temperature indicated by the, 384
Thollon, L., new stellar spectroscope, 821
Thompson, E. H., Atlantis not a myth, 746
— S. P., five laboratory notes from University College, Bristol, 448
— — optical illusions, a correction, 316
— — some new optical illusions, 234
Thomson, E., and E. J. Houston, a curious thermo-magnetic motor, 217
— — transmission of power by means of electricity, 183
— J. S., paraffin and what is got from it, 322
Thorpe, Rucker, Marshall, Green, and Miall, "Coal" (review), 190
Thudichum, J. L. W., "Treatise on the Pathology of the Urine, including a Complete Guide to its Analysis" (review), 124
Thullium and holmium, new elements, 707
Tide-predictor, new, 577
Tidy, C. M., organic purity of potable waters, 321
Tomlinson, C., action of nuclei in supersaturated solutions, 818
Tornado at Wisconsin in 1878, 297
Tornadoes of Kansas and Missouri, 613
Tortoise, new kind of found in China, 389
Tracey, H. A., ancient glacier action in the Punjab, 338
— a visit to the ancient observatory at Delhi, locally known as the "Junter Munter," 787
Trouvé polyscope, 450
"Truth, the Freedom of the" (review), 130
Tungsten-manganese-bronze, 770
Tuning-forks, rate of vibration of, 257
Turkey, mineral wealth of, 590
Turpentine, effect of inhaling oil of, 515
Twining, T., "Science made Easy" (review), 190
Tyndall, J., electric light, 207
— "Fragments of Science" (review), 642

ULTRA-VIOLET rays of the spectrum, absorption of the by organic substances, 198
Unit, standard, of micrometry, 456
"United States Entomological Commission for 1877, First Annual report" (review), 129
"United States Geological and Geographical Survey of the Territories Bulletin" (review), 141, 191
University College, Bristol, five laboratory notes from, 448
"Urine, Pathology of the, including a Complete Guide to its Analysis" (review), 124

VACUA, high, electrical insulation in, 240
— — molecular physics in, 411
Vegetable matter, use of mercurial vapour for studying the structure of, 389
— tissues, double staining of, 328
Venable, F. P., tungsten-manganese bronze, 771
Venus, transit of in 1874, 806
"Vertebrata" (review), 123
Vesuvius, history of during the last ten years, 463
"Victoria, Aborigines of" (review), 569
"Victoria, Natural History of" (review), 439
"Victoria, Reports of the Mining Surveyors and Registrars of" (review), 136
"Victoria, Transactions and Proceedings of the Royal Society of" (review), 437
"Victorian Year-book for 1877-78" (review), 438
Vincent, C. W., magnetic currents in dynamo- and magneto-electric machines, 817
Vine, action of sulphide of carbon upon, 512
Vinegar, action of on alloys of lead and tin, 708
Vivisection Act, report of the Inspector under the, 514
Voisin, A., structure of the brain of idiots, 328
Voltaic pile, new, 265
Vulpian, M., action of certain heat-poisons, 763

WAGNERITE identical with kjerulfine, 269
Water and gas geyser, 805
— colours, arsenic in dark, 586
— thermal conductivity of, 376
Waters, chemical purification of waste, 768
— organic purity of potable, 321
Watts, H. A., "Dictionary of Chemistry" (review), 251
Weather indications, 700
Weber, M., action of vinegar on alloys of lead and tin, 708
Wein, E., J. Nessler, A. Mayer, and R. Heinrichs, cattle food, 326
Whipple, G. M., relation between the duration of sunshine, amount of solar radiation, and the temperature indicated by the black bulb thermometer in vacuo, 384
Wiley, H. W., carbons in the electric lamp, 528
Williams, G., improvements in the volumetrical determination of acids and alkalies, 391
— W. M., contribution to the history of electric lighting, 255
— spider's web for micrometers, 245
— temperature of the sun, 732
Wilson, A., "Leisure Time Studies, chiefly Biological" (review), 131
— J. M., "A Hand-book of Double Stars" (review), 810
— W. J., divisibility of the electric light by incandescence, 450
— harmonograph, 508
Wines, analysis of, &c., 204
Wisconsin tornado, 1878, 297
Wollaston explained the construction of Gower's improved form of Bell's speaking telephone, 449
Wood, C. J., tunnel outlets from storage reservoirs, 813
Words, electrical inscription of, 455
World, organic, action of light on the colouration of the, 650
— — gravitation as a factor in the, 34
Worms in fresh hens' eggs, 702

YORKSHIRE Geological and Polytechnic Society, 331
Young, C. A., note on the unknown chromospheric substance of, 377
Yung, M., action of different coloured light upon the development of animal ova and larvæ, 204

ZEISS, Herr, oil immersion objectives, 456
Zolyet, M., respiration of fishes, 512
Zoological Department of the British Museum, 452
"Zoology and Morphology of Vertebrate animals, introduction to systematic" (review), 368

London: Printed by E. J. DAVEY, Boy Court, Ludgate Hill, E.C.

ROCKS, FOSSILS, MINERALS,
BRITISH AND FOREIGN SHELLS,
CRUSTACEA & ECHINODERMATA.

Single Specimens Supplied, or Collections at One, Two, Three, Five Guineas, and upwards.

GLASS-CAPPED BOXES, TRAYS, TABLETS,
And every Geological Requisite.

MICROSCOPIC OBJECTS
FROM EVERY DEPARTMENT IN NATURE.

THOMAS D. RUSSELL,
48, ESSEX STREET, STRAND, LONDON, W.C.

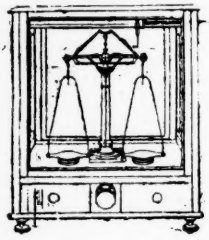
CATALOGUES FREE.

THE CHEMICAL NEWS
Edited by WILLIAM CROOKES, F.R.S., &c.

Published Weekly, price 4d. Annual Subscription, £1, payable in advance.

This Journal is devoted to Scientific and Applied Chemistry, and also embraces whatever tends to elucidate new discoveries in Mineralogy, Metallurgy, Mining, Mechanics, Electricity, and the collateral branches of Physical Science. It also contains an encyclopædic list of chemical papers published abroad during the previous week, with abstracts of all susceptible of advantageous abridgment, thus making the two half-yearly volumes, with their copious indices, equivalent to an English edition of the "Jahresberichte."

LONDON: BOY COURT, LUDGATE HILL, E.C.



L. OERTLING,
TURNMILL STREET,
OPPOSITE FARRINGDON ST. STATION
MANUFACTURER OF
CHEMICAL, ASSAY, & BULLION BALANCES.
Maker to the Bank of England, Assay Office of the Royal Mint, &c., &c.
By Appointment.

COUNCIL MEDAL, 1851.
FIRST CLASS MEDAL, 1854 and 1862.

South London School of Pharmacy,
325, KENNINGTON ROAD.

MANAGING DIRECTOR—DR. MUTER

Daily Lectures on the following subjects:—

Chemistry.	*Physics.*	*Pharmacy.*
Botany.	*Materia Medica.*	*Classics.*

The School has accommodation for One Hundred Students, and contains an excellent Museum and a very completely fitted Chemical Laboratory for Eighty Junior and Twenty Senior Pupils, with water and gas at every working bench.

Registered Lodgings are provided for Country Students, where they can depend on comfort and economy.

For all particulars, enclose a stamped envelope to the Secretary, Mr. W. BAXTER, at Office, Central Public Laboratory, Kennington Cross, London, S.E.

TO MEDICAL STUDENTS.

WILLS'S UNIVERSAL POSTAL SYSTEM.

Mr. WILLS, who has been so successful in preparing Pharmaceutical Students by his Postal System of Instruction, has now published an entirely new Course of Lectures, especially for gentlemen preparing for the Royal College of Surgeons, or the Apothecaries' Preliminary Examinations.
These Lectures have been revised by able men.

Fee for the Entire Course .. .. .. £1 1s.

MEDICAL STUDENTS

Can attend the Chemistry and Materia Medica Classes at the

WESTMINSTER COLLEGE OF CHEMISTRY AND PHARMACY.

To prepare those subjects for their various Examinations.

Terms moderate.

For further particulars apply to Mr. H. WOOTTON, 60, LAMBETH ROAD, LONDON, S.E.

FILTER-PRESSES.

—o—

ORIGINAL INVENTORS AND PATENTEES

NEEDHAM AND KITE,

ENGINEERS,

PHŒNIX IRON-WORKS, VAUXHALL, LONDON.

ESTABLISHED A.D. 1853.

Makers of FILTER-PRESSES of Wood, Iron, Gun-Metal, Copper, Bronze, Lead,

For Freezing, Heating, Washing during Filtration under High Pressure.

Prices according to Requirements.

S.

utical
tirely
Royal

ACY.

AD,

S.

ON.

pper,

re.

XUM